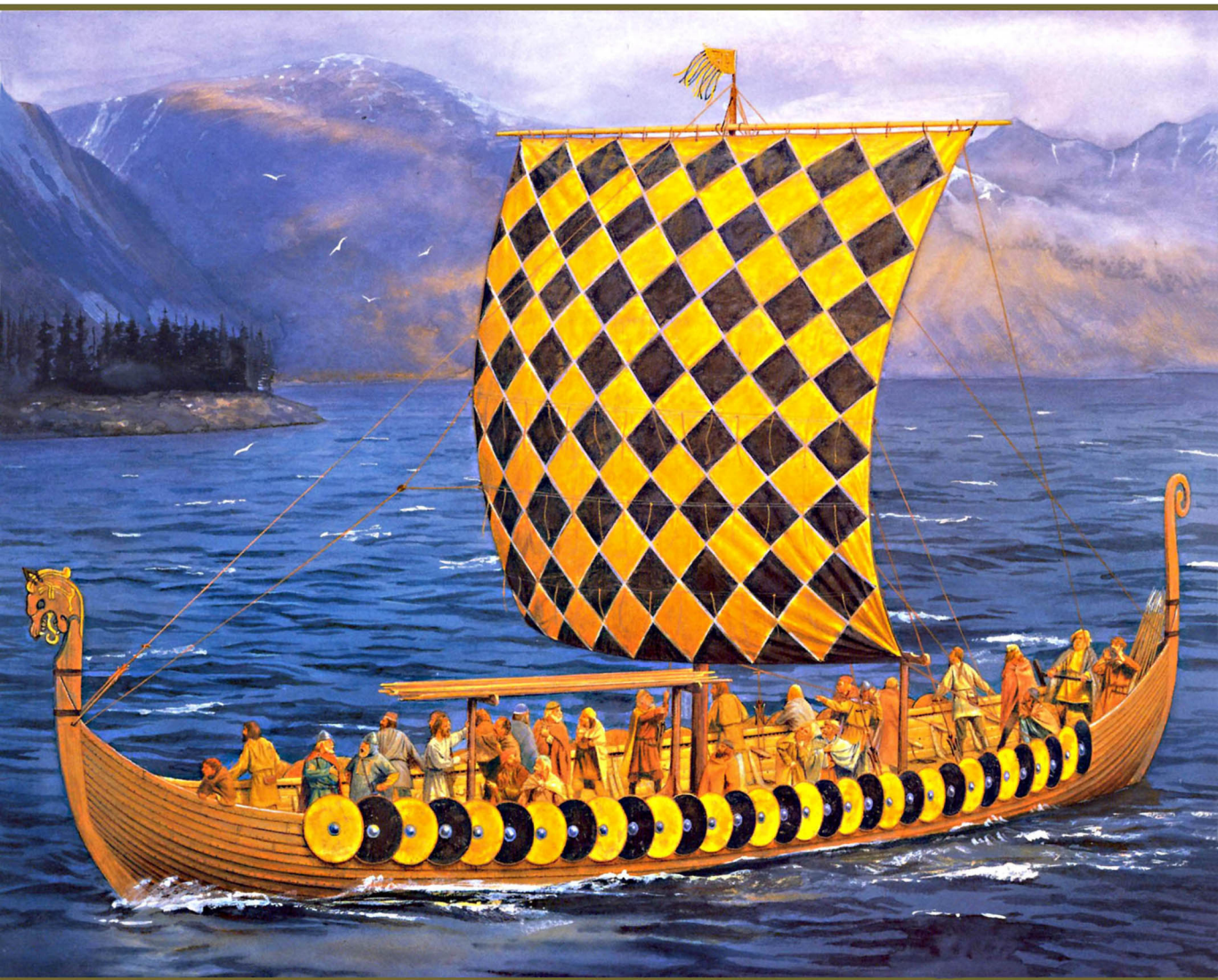
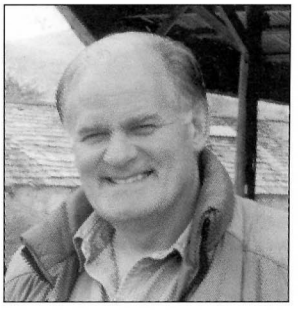
New Vanguard

OSPREY PUBLISHING

Viking Longship



Keith Durham • Illustrated by Steve Noon



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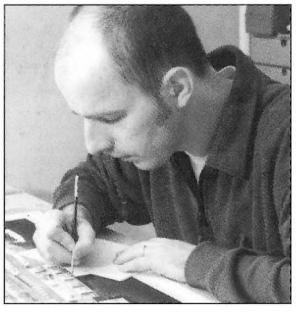

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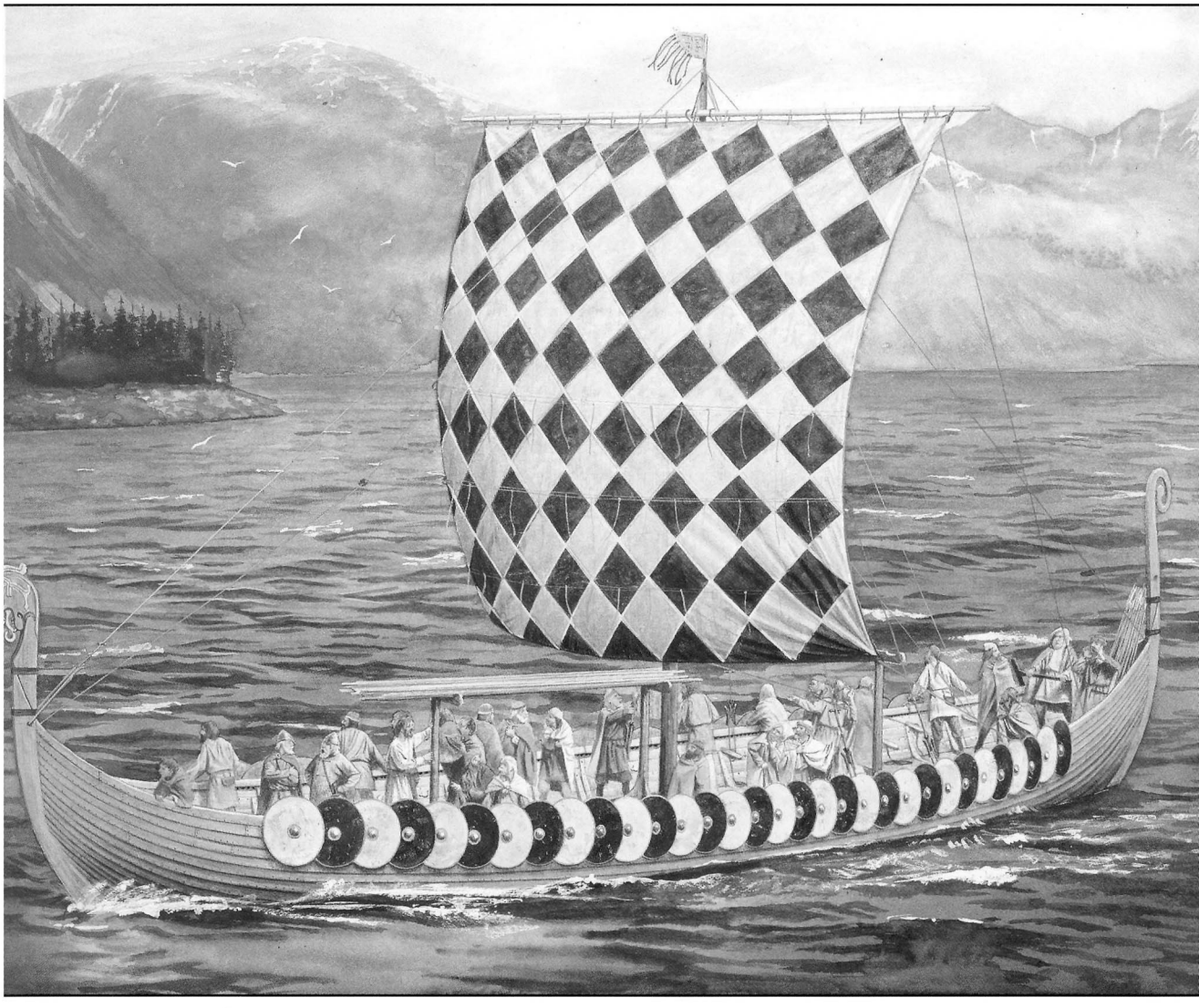

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Author's Dedication

For my mother, Irene Durham 1918–2000

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VIKING LONGSHIP

INTRODUCTION

As the 8th century drew to a close, small bands of marauding Norsemen from Denmark and Norway launched an initial wave of savage amphibious attacks on the kingdoms of western Europe, their first targets the undefended coastal monasteries of England, Scotland, Ireland and France – rich in the gold and silver trappings of early Christianity.

The first of these raids in AD793, at Lindisfarne on the north-east coast of England, was viewed in apocalyptic terms, and left chroniclers stunned by the swiftness and brutality of the attack, and astounded that 'such an inroad from the sea could be made'.

At first, these ominous raids were sporadic, the targets no doubt identified while on trading expeditions, but once the Norsemen realised how lucrative such hit and run attacks could be, they began to return in force. The Viking Age had begun and was destined to last for 300 years.

Prowling across the seas, the Vikings left death and bloodshed in their wake, their ships feared and envied by their victims. The speed, manoeuvrability and shallow draught of these sleek, predatory vessels allowed the Vikings to navigate shallow coastal waters and run their ships on to isolated sandy beaches from where they could launch attacks on nearby unsuspecting settlements. Invariably, before any local force was in a position to retaliate, the Vikings and their ships were long gone.

Their boldness knew no bounds, and by the end of the 9th century large, well-organised fleets overran substantial areas of the British Isles, founding Viking dynasties that prospered under their own kings.

Their ships voyaged south along the coasts of France and Portugal, and rounding Spain, they plundered in Italy, North Africa and Arabia and fought as mercenaries in Crete, Sicily and Asia Minor.

Meanwhile, other bands of Norsemen struck out 'west-over-sea', settling in the Orkney, Shetland and Faroe islands, and then pushing westwards in a wave of expansion that saw them colonise Iceland, Greenland and – albeit briefly – the coast of North America.

The Swedes too played their part. Crossing the narrow Baltic, they followed a network of rivers and lakes through the Russian hinterland, dragging their ships overland when necessary and opening up a network of trading routes that stretched from Byzantium to Birka.

There are few more potent symbols of an era than the Viking longship. To the Vikings themselves, it was the ultimate expression of their energetic culture, its importance reflected in the profusion of ship representations found on their memorial stones and coinage and in their graffiti. Love of their ships also continued into the afterlife, as evidenced in the

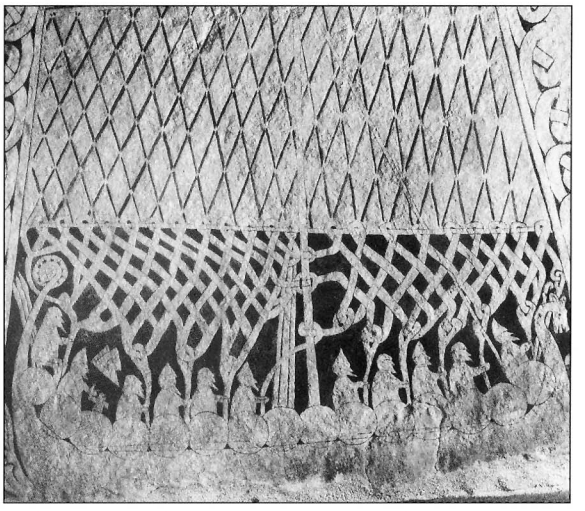
Grotesque, carved animal heads were often used by the Vikings to adorn the prows of their warships. This vigorous carving, found in the Gokstad ship burial, decorated a chieftain's bed post. (Arne Emil Christensen, University Museum of Cultural Heritage, University of Oslo, Norway)

magnificent Gokstad and Oseberg ship burials and in their custom of using a man's ship as his funeral pyre.

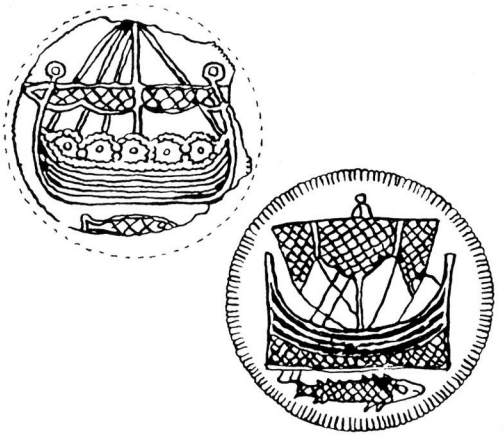
Their pride in these vessels is equally apparent in the great Icelandic sagas where we find names such as '*Oarsteed*', '*Surf Dragon*', '*Fjord Elk*', '*Ocean-Striding Bison*' and '*Great Serpent*' bestowed upon them.

The demands of warfare, trade and exploration led to distinct variations in the basic design of the ships, each kind being distinguished by its own technical name. Small boats were categorised by the number of oars they employed, for example a six-oared boat was known as a *sexaeringr*, and general-purpose ships of 12 to 32 oars, such as the Gokstad ship, were known as *karvi*. Longships, like those found at Ladby and Skuldelev, which had a minimum of 20 rowing positions, were named *snekkja*, which translates as 'thin and projecting', and larger warships, like the Skuldelev 2 and Roskilde 6 longships, were known as *skei*, meaning 'that which cuts through the water'. Giant warships from the latter part of the Viking Age are well documented in the sagas and are called *drekar* or dragons, no doubt in recognition of their fearsomely carved prows. The generic term for all of these warships is *langskip* or longship. Cargo-carrying vessels were known as *knarrs* or *kaupskips*, meaning 'trade ships'.

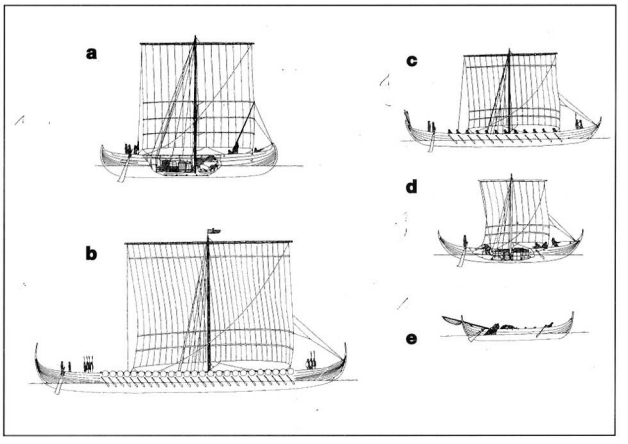
It should be pointed out, however, that contemporary sources sometimes use these terms in a somewhat confusing manner, making it occasionally difficult to place some surviving ship remains into a suitable category.



ABOVE **8th- and 9th-century picture stones from Gotland, Sweden, are a rich source of information on the evolution of the Viking ship. This vessel, depicted on a stone at Smiss, Stenkyrka, is clearly a warship. Note the dragon-prow and decorated sternpost, the row of overlapping shields and the intricate system of reefing lines attached to the sail. (Harald Faith-Ell, Antivarisk – Topografiska Arkivet, National Heritage Board, Stockholm)**



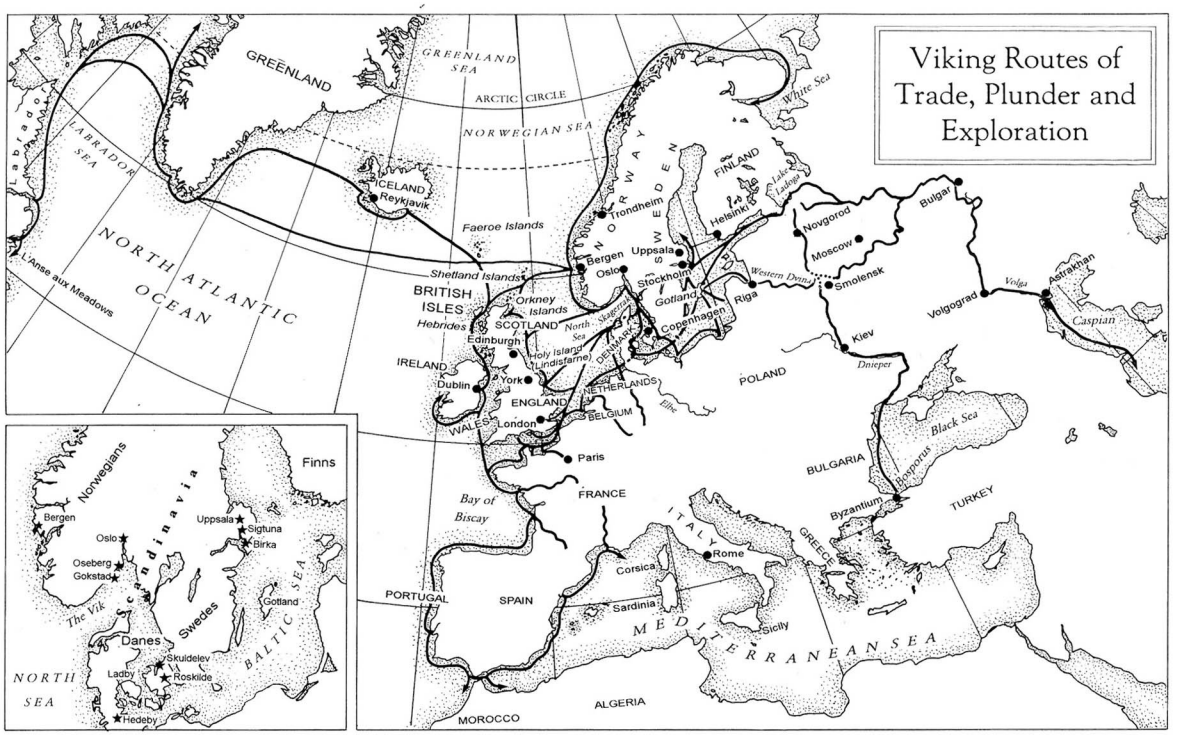
Defining the dual role of the Vikings as warriors and traders, these two 9th-century silver coins show a high-prowed warship displaying a shield-row, and a sturdy cargo ship or *knarr*, with a reefed sail, shrouds, braces and bowline. (G. Challis)



Reconstructions, drawn to the same scale, of the five 11th-century Skuldelev ships salvaged from Roskilde Fjord. Although they all share the same basic construction, each vessel has evolved in accordance with its particular role. (a) *knarr*, (b) longship, (c) small warship, (d) coastal trader, (e) fishing boat. (Morten Gøtche, The Viking Ship Museum, Roskilde)

THE EVOLUTION OF THE VIKING SHIP

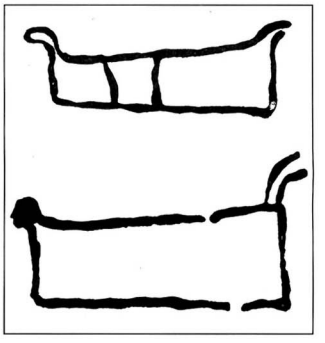
The fragmented geographical nature of Scandinavia bred a hardy race that was as much at home on water as land, the profusion of fjords, lakes and rivers invariably making the journey between two points quicker if undertaken over water. As we shall see, this seafaring culture would develop a line of vessels that would evolve through the Stone Age, Bronze Age and Migration Age, culminating in the magnificent ships built between the 9th and 13th centuries.



EARLY SKIN AND LOG BOATS

Sometime at the close of the Ice Age, between 8000 and 6000BC, bands of nomadic hunter-fishers roaming ever northwards in the wake of the retreating ice, began to settle along Norway's north-western coast.

Hunting across land and sea and exploiting the abundance of marine life in off-shore fishing grounds, they used the sea as their highway, and from the very beginning seaworthy boats were a crucial element in their lives. Experts generally agree that the craft in which they braved these icy seas were similar in form to the arctic *umiak*. In a design that has remained unchanged to this day, the *umiak* is constructed by stretching and sewing overlapping waterproofed seal skins over a wooden framework of ribs and longitudinal stringers. The cultural importance of such boats to these people is reflected in the numerous depictions of them in prehistoric rock art. The most famous examples can be found at Evenhus, near Trondheim, where a collection of carvings, boldly incised into a rock



Two Stone Age rock carvings from Evenhus, northern Norway, depicting what are thought to be skin boats similar to the arctic *umiak*. (G. Challis)

face, depict a very specific type of craft. Deep sided and tub-like in appearance, these boats certainly bear a striking resemblance to the *umiak*. The ends of their hulls rise sharply, one end usually terminating in a kind of lip, the other – which is generally higher – often ending in two short, curved, parallel lines. These two lines, which probably depict the prow, have been interpreted as handles, a feature of the *umiak* that is essential when beaching such a delicate craft. Some of the boats also have vertical or horizontal lines carved inside their hulls, possibly an attempt to depict the aforementioned wooden framework.

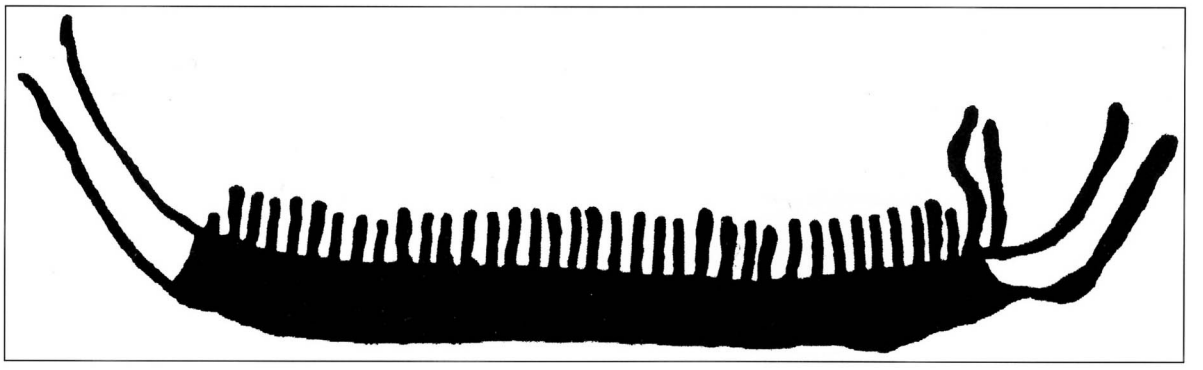
Meanwhile, in southern Scandinavia, men were also venturing out on to the water, and while no doubt aware of the skin boat, these inland tribes, taking advantage of vast areas of forest, began constructing log boats of gradually increasing sophistication. These ranged from small, simple dugouts, perhaps 4 metres long with a narrow beam of less than 1 metre, to much longer examples which may have been stabilised by outriggers and given a higher gunwale by attaching additional pieces of wood to the sides. These boats, while perfectly adequate for fishing and limited travel on calm, inland waterways, would have been quite unsuitable for any kind of ocean-going activity. They did, however, give rise to a wood-based boatbuilding tradition that absorbed the technology of the skin boat, and, by the Bronze Age, had begun to produce Scandinavia's first plank-built vessels.

The Hjortspring Boat

For the northern world, the coming of the Bronze Age heralded an era of thriving trade and expansion, and it was the lure of wealth that would be the catalyst in the next stage of Scandinavian marine development.

With the introduction of metal into northern Europe near the end of the third millennium BC, shipbuilding techniques began to evolve as never before. Over the centuries, the search for copper and tin, necessary for the production of bronze weapons and tools, led to ever expanding areas of trade and broadened Scandinavian seafaring experience. This in turn led to increasing refinements of design which, by 1500BC, saw these people voyaging far beyond their native waters and, while staying in sight of land, making regular trading expeditions to Britain, Ireland and possibly even to France, Spain and the Mediterranean.

Once again, the importance this society placed on its ships has left us with thousands of rock carvings in Norway, Denmark and Sweden, which form a unique archive of these Bronze Age craft. What we see in the main



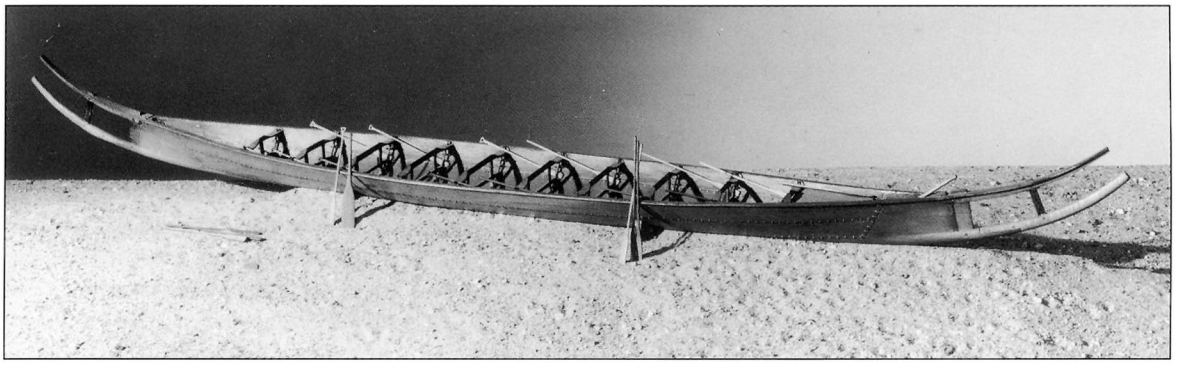
This Bronze Age rock carving from Bardal, Trøndelag, Norway clearly depicts a vessel of the type found at Hjortspring, Denmark. Many of these carvings feature vertical lines rising from the hull, which may represent the crew or perhaps the number of paddles deployed. (Author)

are flotillas of broad-beamed, open boats with keels and gunwales that project like beaks fore and aft, well beyond the hull. Some of the craft are small and plain, while others, elaborately detailed, feature prows terminating in animal heads and stylised depictions of the crew, who are either paddling the craft or in some instances brandishing weapons.

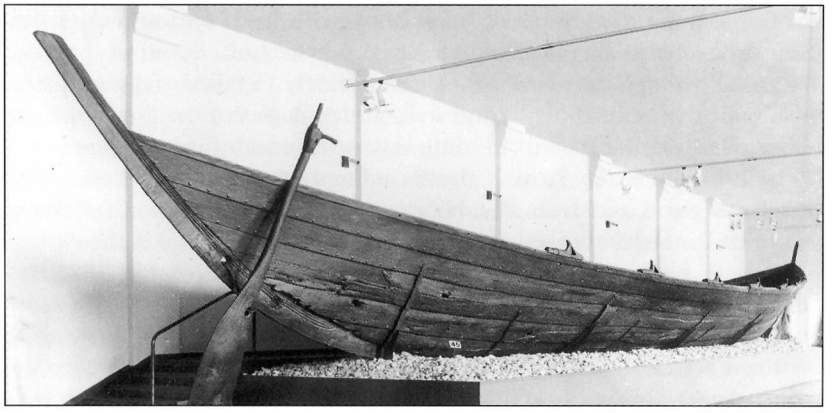
In 1921 the reality behind these carvings came to light when such a vessel was excavated from the Hjortspring bog on the island of Åls in southern Denmark. Presumably seized as a trophy of war, it is the earliest plank-built boat yet discovered in Scandinavia, and around 350BC had been filled with the captured weapons and equipment of a defeated enemy and sunk in the bog as a votive offering. Although the Hjortspring boat can actually be dated to the early Iron Age, its resemblance to the vessels depicted in rock carvings from the Bronze Age is obvious. Just over 18 metres long and two metres wide amidships, the hull consists of only seven pieces of lime-wood sewn together with gut and caulked with resin. The boat would appear to be a large war canoe and was equipped with a steering oar at each end and paddles for 20 men. The bottom is formed from a single broad plank, which is dished out and fashioned in a gentle curve running fore and aft. As the plank becomes narrower at each end, the hollowingout becomes more acute and here separate end pieces, similarly hollowedout, are sewn on to the bottom plank and form the prow and stern. It is from the boat's bottom plank and these pre-cut end pieces that the curious beak-like projections extend, forming the double prow and stern that characterise these vessels. Completing the hull are two broad, overlapping planks on each side that are sewn to the bottom and form a garboard and sheerstrake. These planks do not meet where they converge at the bow and stern, but instead are run into the hollowed-out end pieces.

The inner supports consist of slender hazel branches that are curved like ribs from gunwale to gunwale, spaced 1 metre apart and lashed to the hull by means of cleats left proud when the planks were formed. This unique method of construction, which gives a remarkable degree of flexibility to the overall structure of the vessel, would continue well into the 10th century. Spanning these ribs are thwarts for the crew, which are angled in such a way as to maximise the power of a downward paddle thrust. The double row of props supporting them further strengthen the thinly planked hull.

From an evolutionary point of view, the Hjortspring boat is an almost perfect amalgam of the principal elements of both skin and log boat



A small-scale reconstruction of the Hjortspring boat, 350BC. A full-scale replica, the '*Tilia*', was recently tested out by an experienced crew employing 18 paddles. The boat proved fast, manoeuvrable and seaworthy, and in sheltered waters it averaged a respectable 6 knots. (Natural History Museum of Denmark)



The reconstructed 4th-century Nydam ship. In an attempt to *counteract* the inherent weakness of the bottom plank, the ship has been given a rather narrow profile and sharp bows. Note the archaic rudder and the rowlocks lashed to the gunwale. (Archäologisches Landesmuseum, Schleswig, Germany)

construction, and embodies the strength, lightness and flexibility that would become the hallmarks of Scandinavian shipbuilding. That these virtues had been consolidated and improved upon over the next 700 years became evident when an ocean-going vessel from the dawn of the Migration Age was discovered at Nydam in south Jutland in 1863.

The Nydam Ship

Like the Hjortspring boat, the largest vessel found at Nydam was undoubtedly a warship and had been filled with military equipment before being sunk as a sacrificial offering around AD350–400. The ship is a massive, clinker-built, open rowing-boat measuring about 23.5 metres long, 3.5 metres wide and 1.2 metres deep. Built entirely of oak, its spine consists of a bottom plank to which are fixed raked stem and stern pieces. The hull is completed by 10 strakes, which are attached 5 to each side of the bottom plank, the sheerstrake being reinforced by a scarfed gunwale. All 10 strakes are fixed to the stem and stern, which are rebated to receive them. Running the full length of the hull, each strake, measuring over 20 metres long and 50 centimetres wide, is formed from a single piece of timber. Although primitive in concept, the mere production of such a colossal, flexible plank testifies to the skill of these Iron Age shipwrights. Unlike the Hjortspring boat, these overlapping, or 'clinker-built' strakes are not sewn together, but are riveted with iron nails clenched over small, square roves on the inside of the hull, the first example of a tradition that persisted through the Viking Age to our own day.

The ship's substantial ribs are hewn from suitably formed timbers and are lashed to the hull via cleats left standing proud on the planking. Fifteen thwarts, spaced 1 metre apart and supported by a series of props, would have accommodated the oarsmen and complete the skeleton. The vessel was propelled by 30 oars, and a similar number of barb-shaped rowlocks were lashed to the gunwales. The ship was steered by a large, paddle-shaped rudder, which was found near the stern. No trace of any fixture for a mast was found and it is unlikely that so narrow and steep-sided a vessel could have been sailed with any degree of confidence. That does not mean to say that the vessel was unseaworthy, for it was in such ships as those found at Nydam and at Sutton Hoo in East Anglia that Saxon warriors crossed the North Sea to raid and later colonise England. We can be sure, however, that some of these voyages in such shallow open vessels, which had no keel and could be prone to hogging or swamping, ended in disaster.

Nevertheless, the advances made in the Nydam ship are obvious: a fixed steerboard and oars replacing paddles provides a more efficient method of steering and propulsion, and iron-riveted planking ensures a more robust and secure hull. What is still lacking, however, is the strength and stability that would be achieved by the introduction of a keel.

That this problem was at least partially overcome by the beginning of the 8th century is apparent in the Kvalsund ship, excavated at Sunmøre in western Norway.

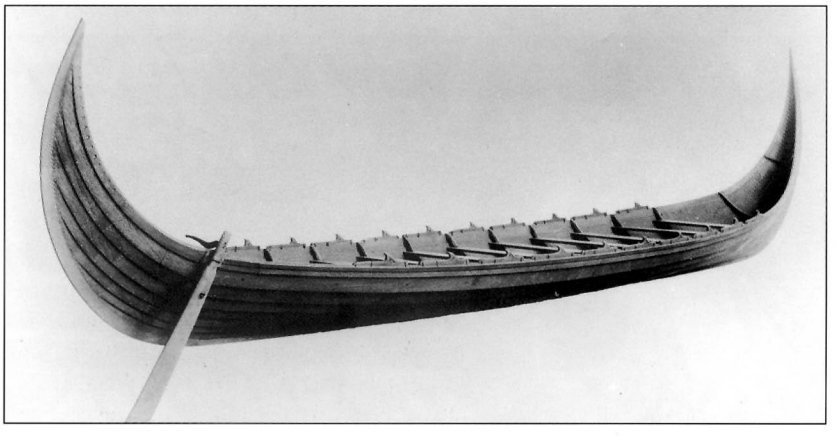
The Kvalsund Ship

Built around AD700, the Kvalsund ship is a large, open, sea-going vessel 18 metres long, 3 metres wide and 80 centimetres deep. Like the two previous craft described, it was deposited in a bog as a votive offering and is the first vessel found in Scandinavia that utilises a keel.

Although the ship's backbone still consists of a bottom plank, it is fashioned in such a way as to create a thick integral runner along its external length, and a rudimentary keel has been formed. Although far from perfect, the arrangement is a major step forward, strengthening the bottom of the ship against hogging and facilitating the shaping of a graceful, broader and more spacious hull. More importantly, the stability achieved presents the option of mounting a sail, for the provision of a keel also allows a vessel to partially heel over when under sail without capsizing. Although no mast or rigging was discovered, everything about this ship's construction points to an ocean-going vessel that could be sailed or rowed.

The clinker-built hull is entirely constructed of oak and is fixed with iron rivets. Now, however, the strakes have become narrower, there are more of them and each strake is fashioned from several lengths of timber. This gives an even greater degree of flexibility to the hull and cuts out the arduous task of locating and preparing the enormous lengths of timber previously required. The ship's ribs are of pine and are lashed to the hull, but in this case not to the bottom or keel-plank, thus allowing the flexible hull to 'work' independently of the keel in heavy seas. Ten rowlocks are fixed to each gunwale by wooden pegs, known as trenails, and 11 evenly spaced thwarts, or crossbeams, 1 metre apart, brace the structure and double as benches for the oarsmen. The two high, curving stem and stern pieces are lightly decorated and are fixed to the keel-plank by flat joints.

In addition, we also witness in the Kvalsund ship the first example of what was to become the classic method of mounting a fixed rudder to the right side of the hull aft, the 'steerboard' or starboard side (from the Old Norse *styri*, to steer). A cone-shaped boss is nailed to the hull, and a withy passed through the rudder is threaded through holes drilled in the boss and hull, and made fast inboard to a triangular-shaped rudder rib, which is strengthened on the starboard side. The rudder rib and a matching forward bulkhead are not lashed, but nailed to the hull, their sides carved in a series of steps to accommodate the ship's overlapping strakes. The neck of the rudder is secured to the gunwale by means of an adjustable strap, and a tiller facilitates steering. This arrangement, while securing the rudder in



This model of the Kvalsund ship shows to perfection the sleek lines that clearly anticipate the magnificent vessels of the Viking Age. Note the classic arrangement of the 'steerboard' and the low-slung, roomy hull. (Bergens Sjørfartsmuseum, Norway)

an efficient manner, still allows it the flexibility to turn on its own longitudinal axis.

Almost every element of the Kvalsund ship's construction places it firmly at the beginning of a new era of Scandinavian shipbuilding technology, which would come to its full flowering in the 9th and 10th centuries.

The Sail

Perhaps the most enduring mystery in this process of evolution is why it took such a resourceful, seafaring people until the 8th century to adopt the sail. The first evidence for its introduction in Scandinavia comes in the form of ship depictions on early 8th-century picture stones from the island of Gotland in Sweden, but being such energetic traders it is difficult to believe that the Scandinavians were unaware of its existence before then. By that time the sail had been widely used in the Mediterranean for centuries and must also have been a familiar sight in parts of western Europe where Roman influence had prevailed (although that influence never actually extended into Scandinavia).

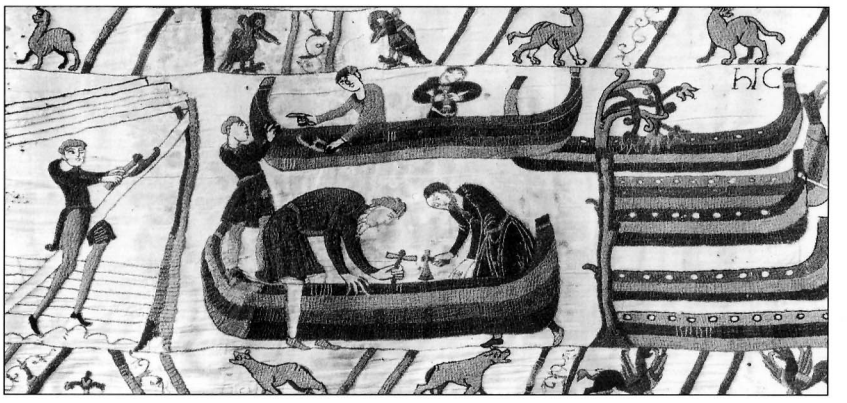
One reason for this apparent lack of enterprise may be that prior to the 8th century, while overseas voyaging was not uncommon, most marine activity actually took place in Scandinavia's coastal waters, where oar power was an adequate means of propulsion. In other words, the sail was not a prerequisite for water-borne travel.

Also, until the emergence of the Kvalsund ship, the lack of a keel and the reliance on a bottom plank had effectively constrained ship design, producing narrow, sharp-sided vessels that did not readily lend themselves to the stress and strain imposed by mast and sail.

The truth is, we do not really have a satisfactory answer to the question, but once the sail was – quite literally – taken on board, its use brought about a number of significant changes in the way that ships would be constructed in the Viking Age.

THE VIKING AGE

With the introduction of a true keel, sturdy and T-shaped in cross section, the bottom of the ship began to expand in a series of gently sloping, clinker-built strakes. Below the waterline the ribs were still lashed to the



The shipbuilding scenes from the Bayeux Tapestry are a primary source of information on the tools employed by Viking shipwrights. The artisan on the far left uses a T-shaped axe to smooth and shape planking, which he wedges in the crook of a tree. Under the watchful eye of a master shipwright, the man in the upper ship trims the hull with a T-shaped axe while his companion bores holes with a breast-auger. Below them, the man on the right works with a small side axe, the other seems to use a hammer. Note the finished ships on the right, ready for launching. (The Bayeux Tapestry, 11th century. By special permission of the City of Bayeux)

strakes via cleats but, as we have seen, not to the first strake, or garboard, and keel. Where the bottom strakes meet the waterline, what had previously been a reinforced gunwale was now transformed into a significantly thicker strake known as a *meginhufr* (Old Norse: 'strong plank'). This strake, which along with the keel provided longitudinal strength to the ship, also substantially reinforced the hull where it met the waterline and facilitated the transition from bottom to sides. Attached to it were crossbeams, which spanned the tops of the ribs and were fixed to them with trenails. In order to avoid the ship being swamped while heeling over when under sail, the ship's sides were heightened by the addition of a number of strakes. As the upper strakes also had to withstand buffeting from waves and endure the strain exerted on the hull while heeling over, they were nailed to L-shaped knees which in turn were attached to each end of the crossbeams. Further support was provided by a series of top ribs, one for every other knee.

The higher gunwales made the use of rowlocks impracticable, so now oar holes were pierced at an appropriate height in one of the upper strakes, which was generally made thicker in order to absorb the wear and tear generated by rowing. The crossbeams that previously served as benches for the oarsmen were now redundant for that purpose and were rebated to receive a deck of carefully fitted planking that was generally left loose, allowing access to the hull for baling, repairs and storage. Support for the mast began immediately above the keel in the shape of a massive block of timber known as the *kjerringa* (Old Norse: 'the crone') or keelson. Resting over the keel but not actually attached to it, the keelson might span up to four ribs, to which it was fixed with trenails. Fitted with a socket to take the mast, its primary function was to evenly spread the weight of the mast and the strain exerted by it when the ship was under sail. Immediately in front of the socket, the keelson sprouted a vertical arm that supported the mast until it reached deck level. Here, the mast was braced by another large block of timber that was slotted fork-like to accommodate it. Known as a 'mast-partner' or 'mast-fish' from its fish-tailed shape, this humpbacked member straddled four or six crossbeams into which it was rebated and fixed with trenails. Additional support on each side was provided by knees, nailed to it and the crossbeams. The mast was further secured by shrouds and fore and back stays. A large deep rudder was attached to the starboard side aft, as described on the Kvalsund ship.

It is important to remember that these innovations, which took place over 150 years and culminated in such magnificent vessels as those found at Gokstad and Oseberg, were only made possible by the consummate skill of the Viking shipwright.

SHIPWRIGHTS AND SHIPBUILDING

A master shipwright would have had a team of artisans working under him, all of whom would be skilled in one task or another. One of the most important of these tasks was the ability to identify in the forest those trees that would lend themselves to the shaping of various parts of the ship's structure. Tall forest oaks would provide timber for the keel and planking, while masts, yards, spars and oars would be cut from pine. Isolated field

oaks with low-curving boughs would be valuable for ribs, stem and stern pieces, and a mast-fish or rudder could be formed from the thick trunk. Where possible, a carpenter would also take advantage of the strength of a natural joint where a branch grew out from a trunk, as when fashioning a keelson with a vertical supporting arm. Smaller, naturally angled pieces of timber were worked into knees of varying size and into rowlocks for smaller craft.

The task of locating such trees was generally undertaken in the early winter when they were easier to identify and when the lack of undergrowth made the transportation of timber to the shipyard less arduous. Also, freshly cut timber is generally more stable in cold weather and is less likely to dry out and crack before it is used. Trees would be carefully felled using axes and wedges and, when appropriate, would be cleaned and split on site. No doubt on occasion, the master shipwright himself would supervise the felling of a particular tree from which would be fashioned the keel or other parts that were critical in the ship's construction.

Planks were formed by splitting logs radially, using axes, chisels and wooden or metal wedges. First, the logs were split in half, then quartered, then split into eighths and so on until a trunk 1 metre in diameter produced around 20 planks. The saw was never used in this process, for by splitting logs this way and following the grain instead of cutting across it, the carpenter did not compromise the strength of the timber. He was then able to produce thin, incredibly flexible planking that, if used while still green, could be curved and twisted when forming the hull. As we will see, the bottom planking on the Gokstad ship was only 2.6 centimetres thick.

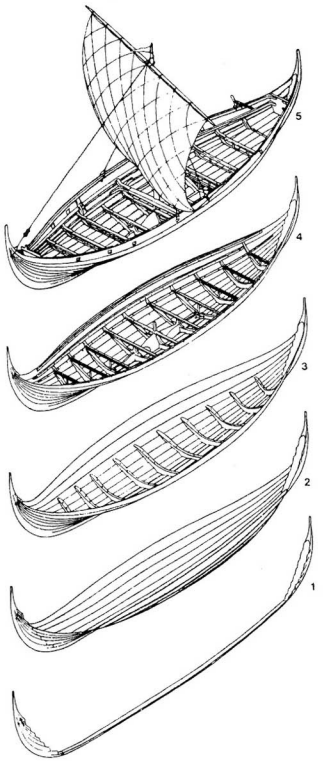
Very few parts of the felled tree would be discarded. Wood was also required for trenails, rigging blocks, stringers, rakkes, clamps and the stocks on which the ship was built. Bast fibres, found just below the bark, were twisted into rope, while sawdust and chippings were used for firewood and to smoke fish, cheese and meat. In addition, partly finished timbers that could be used at a later date have been found in bogs where they had been stored to keep them moist.

Close examination of the wood used in Viking ships indicates that the axe was by far the most important of the shipwright's tools. This is also evident in the shipbuilding scenes depicted in the Bayeux Tapestry, where no fewer than four different types of axe are being used to fell trees, lop branches and fashion and finish planking. Also in use were the adze, gouge, plane, hammer, chisel, auger, various moulding irons and the knife. There is, however, little evidence of the saw, although it must have been used on occasion.

Working closely with the shipwright was the blacksmith, who would maintain the tools, forge new ones and produce the thousands of nails and roves used in a ship's construction.

A shipwright did not rely on plans to build his ship, but worked instead within a tradition passed down through successive generations, where an experienced eye and rule of thumb dictated the vessel's final shape and size. Whether the commission was for a warship, *knarr* or coastal trader, each ship shared the same basic characteristics, and by not straying too far from acceptable ratios of length, breadth and depth, the shipwright could incorporate specific demands or regional variations into his design.

In the tradition of the Hjortspring, Nydam and Kvalsund vessels, ships of the Viking Age were built using the 'shell first' method of construction,



The five stages of construction common to all ships in the Viking Age. The keel was laid, and the stem and stern attached. The shell was then formed, strengthening ribs were fitted, followed by the keelson and crossbeams. The vessel was then ready to be fitted out with mast, sail, rudder and rigging. This particular ship is the small coastal trader, Skuldelev 3. (Drawing – Morton Gøtche, the Viking Ship, Museum, Roskilde)

internal reinforcements only being installed when the bottom strakes reached the waterline. Construction began by preparing the T-shaped keel, laying it on secure, level stocks and using heavy rocks to jam it in an upright position. Fore and aft stems were then scarfed to the keel and the whole structure firmly supported at each end by a pair of tall wooden props. This initial stage would have always been closely supervised by the shipwright, as a poorly shaped keel or badly scarfed stems could have far-reaching consequences not only for the ship's handling qualities, but could also result in the subsequent misalignment of other elements in the vessel's structure. Once the keel was laid and the ship's spine completed, the shaping of the hull could begin.

Each individual strake was made up of a number of scarfed pieces, every overlapping joint being secured by three nails clenched inboard over small iron roves. Traditionally, the external open end of these joints would always face aft in order to minimise any ingress of water. When building up the hull, it was also important to ensure that such joints were staggered and not placed one above the other, where they could create a potential weakness. If this was allowed to happen, the ship was said to be 'pieced'.

The strakes were not cut straight edged, but were shaped in relation to their position in the hull, and were trimmed using a side axe. The upper external edge, the 'land', was planed back in order to form a smooth, angled surface and ensured a flush fit where the next strake overlapped. Just above the lower internal edge, a groove was incised using a moulding iron and into it was stuffed a twisted rope of animal hair, generously caulked in pine tar, making the joint as waterproof as possible.

Having shaped the first, or garboard strake it would then be bored and nailed to the underside of the projecting ridge at the top of the keel. This joint could be prone to leaking and consequently was well packed with rope and tar. The second strake was then caulked and clamped to the garboard, and where they overlapped, holes were bored at approximately 18-centimetre intervals and the two strakes were secured together with iron nails. A third strake was attached to the second in a similar manner, then riveted, and so on, until the hull was complete. As each subsequent strake was added and the shape of the hull began to emerge, the shipwright could determine its symmetry at the clamping stage by varying the angle or width of each strake in relation to its neighbour.

While this would be achieved largely by means of a practised hand and experienced eye, some experts feel that at this stage the shipwright may have availed himself of a boat ell. This was a long stick marked with pre-recorded measurements, which allowed him to check the position of each strake at various points along its length against a series of knots in a fixed line running from stem to stern. As an alternative, templates may have been used, or some kind of boat level to measure the angle of the strakes. It should be stressed, however, that many shipwrights, including some traditional boatbuilders in Scandinavia today, would shun the use of such aids.

Once the *meginhufr* had been attached at the waterline, the keelson, ribs, crossbeams and vertical knees would be fitted. Four to six strakes per side would be added above the *meginhufr*, oar holes pierced and the upper ribs attached. The mast-fish would be fixed to the crossbeams and a rudder fashioned and secured starboard aft. The ship would be given numerous coatings of pine tar and then launched. She would be checked

The Skuldelev 3 replica '*Roar Ege*' under construction at Roskilde. Note the stocks and the jaw-like clamps that hold the strakes in position. This scene would be familiar to a Norse shipwright 1000 years ago. (Viking Ship Museum, Roskilde)

for leaks, and ballast would be added and adjusted until the shipwright was happy with the way the vessel sat in the water. The ship was then ready for fitting out.

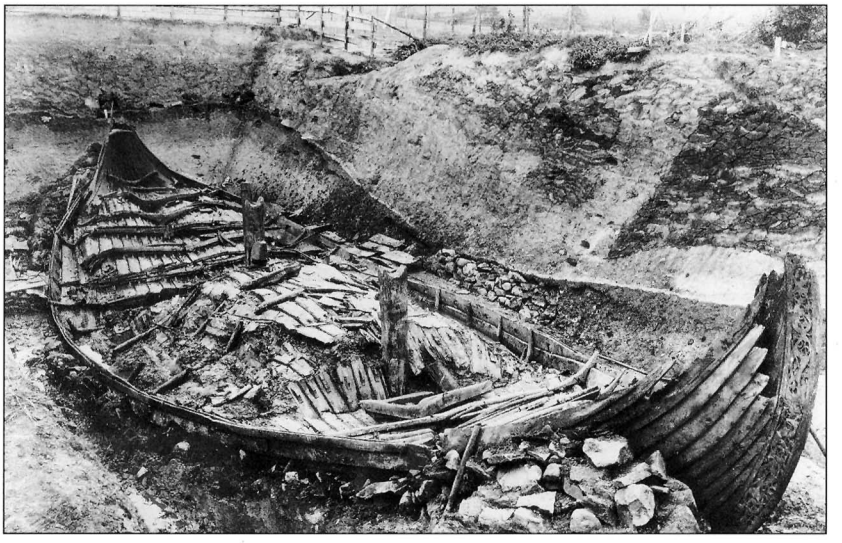
The mast was stepped and a yard secured to it by means of a rakke. If the vessel was a trader, two to four oars would be fashioned, but if it was a warship this could involve producing between 30 and 60 oars of varying lengths. Decking would be laid, cleats fitted, then, depending on how affluent the prospective owner felt, the ship could be furnished with a gangplank, balers, water barrels and an iron anchor, which would be forged by the blacksmith and no doubt constituted a major expense in itself.

Working in close proximity to the shipyard would be craftsmen and women who would produce sails and a variety of ropes used in the ship's rigging. The archaeological and documentary evidence for sails and rigging from the Viking Age is minimal, but close examination of ship representations on picture stones and coins from the 8th to the 11th centuries give us some useful clues; so too does the study of ethnological material from northern Norway, where up to the middle of this century traditional fishing boats still relied on large rectangular sails for propulsion. As far as we know, sails were generally woven from coarse wool, were sometimes of double thickness and were waxed or oiled to proof them against the elements. In order to stop them sagging and losing their shape when they did become sodden, they may have been reinforced by a diagonal latticework of rope, or thin leather strips. It is possible that many of the ships portrayed on the 9th-century Gotland picture stones depict just such an arrangement, which would certainly create the distinctive diamond patterns so often displayed on their sails.

Most of these depictions also show a web-like arrangement of what appear to be reefing lines running from the lower edge of the sail. These may well have functioned in a similar fashion to lines used on northern Norwegian fishing boats, which were loosely woven through the sail cloth, and when tightened would bunch up the areas between them, thereby reducing the area of sail. Alternatively, three or four horizontal rows of reefing lines may have been employed, allowing the sail to be rolled up, tied and effectively shortened. The edges of the sail would invariably have been strengthened with a border of rope, which would also have acted as a point of purchase for the priares, sheets, bowline and tackline.

Ropes were fashioned from horsetails, bast, hemp, and the skin of the walrus, whale and seal. From what evidence we have, standing rigging was both simple and minimal. Picture stones, coins and graffiti invariably depict vessels with two or three shrouds supporting the mast. These were apparently secured by means of cleats on the upper strakes, or via holes bored through the ribs or through iron osier rings attached to ribs or beams. Additional support for the mast was provided by fore and back stays secured near the prow and stern. Running rigging no doubt included a halyard, which, passing through a hole near the top of the mast, facilitated

the hoisting and lowering of the yard and sail. The angle of the yard would have been determined by two braces, while sheets, tacklines, priares and a bowline would have given ample control of the sail. Cordage was manoeuvred by a variety of blocks, rope-cleats, beckets, shackles and shroud pins, some of which have survived in the Oseberg and Gokstad burials. Ideas of how they functioned, however, can only be speculative.



The 9th-century Oseberg ship during its excavation in 1904. The burial chamber has been removed, and clearly visible on the strakes in the foreground are the integral pierced cleats by which they were lashed to the ship's ribs. (University Museum of Cultural Heritage, University of Oslo, Norway)

KARVI

By the beginning of the 9th century, advances in ship design and the experience gained under sail by two generations of Norse seafarers led to the first Viking attacks on the coasts of Europe. It is almost certain that the ships they employed were *karvi*. Equally at home as a raider, trader or coastal pleasure craft, well-preserved examples of such vessels were discovered in royal burial mounds at Gokstad and Oseberg in Norway.

The Oseberg Ship

The Oseberg ship, without doubt the most spectacular vessel to have

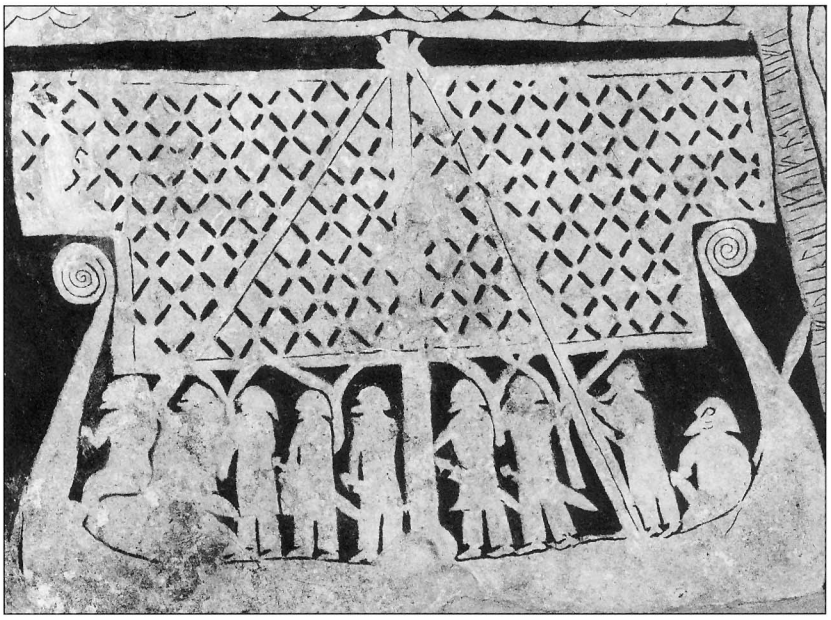
The beautifully restored Oseberg ship as she is today in the Viking Ship Museum, Bygdøy, Oslo. Thought to be the final resting place of Queen Åsa, the Oseberg ship is a testimony to the skills of the Viking craftsmen who built her. (University Museum of Cultural Heritage, University of Oslo, Norway)

survived from the Viking Age, was excavated throughout the summer of 1904 on a site near the Oseberg farm on the western side of Oslo Fjord in the county of Vestfold, Norway.

The ship had originally been covered by an impressive grave mound measuring 6.5 metres high and over 40 metres in diameter, but when Professor Gabriel Gustafson began his excavation, centuries of subsidence had reduced the height of the mound to a mere 2.5 metres. As the mound had settled, the resulting compression formed a virtually airtight seal over the grave, and this factor, combined with the unique preservative qualities of the damp blue clay in which the ship rested, kept decay to a minimum and helped preserve not only the ship, but almost all of the ancillary equipment buried with it.

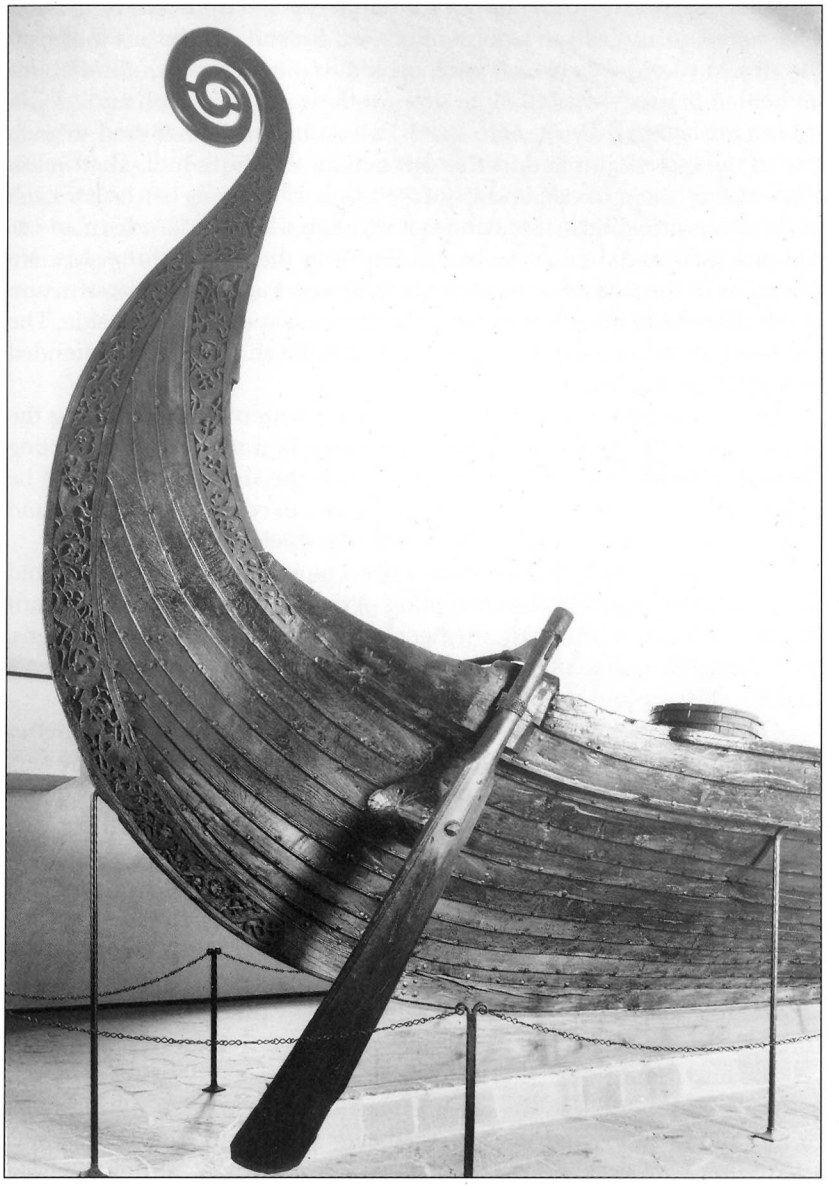
By carrying out dendroanalysis on the oak logs used to construct the burial chamber, it has been possible to date the interment to the year AD834. The ship, however, had been built many years before, the decoration on its prow and stern dating it to around the year AD800. Smaller than a regular longship, it falls into the *karvi* class of vessels, and, as we shall see, was designed as a high-born person's pleasure craft.

Except where noted, the ship is constructed entirely of oak, is 21.58 metres long and 5.10 metres wide at its broadest point amidships. It is a very shallow vessel, the height from the base of the keel amidships to the gunwale being a mere 1.58 metres. The keel is T-shaped in cross section, is 19.80 metres long and is made from two pieces of timber. These are joined about 4 metres from the stern by means of a scarf joint secured by iron rivets. Amidships, the keel is 25 centimetres deep and 20 centimetres wide, tapering to 13 centimetres towards the prow and stern. The base of the keel is formed in a long shallow curve running fore to aft, placing the greatest draught amidships where the hull is broadest and making the ship very easy to turn. The prow and stern are cut from carefully chosen pieces of oak and are secured by scarf joints where they join the main keel timber.



The ship depicted on this 8th-century picture stone from Tjängvide, Gotland, bears a striking resemblance to the Oseberg ship, an indication perhaps that the royal burial vessel was not unique and that ships of a similar design existed in other parts of Scandinavia. Note the shallow freeboard and the ubiquitous chequered sail. (Antivarisk – Topografiska Arkivet, National Heritage Board, Stockholm)

The hull is made up of 12 overlapping strakes, nine of which form the bottom of the ship. A tenth, the *meginhufr*, facilitates the transition from bottom to side, the eleventh and twelfth being the only two strakes above the waterline. Where the strakes overlap they are caulked with tarred wool and riveted together using round-headed iron nails clenched over small square roves in the usual clinker-built way. The individual strakes are at their thickest amidships and tend to taper towards the bow and stern. The nine strakes below the waterline, which need to be thin and flexible, are trimmed to a thickness of 2 centimetres, whereas the eleventh and twelfth, which need to be stronger, are between 2.5 and 3 centimetres thick. As usual, the *meginhufr*, given its strengthening role, is of a much heavier construction. Resembling an inverted L, it juts out like a cornice at the waterline, allowing the gently angled strakes below to meet the two upper



The magnificent stern section of the Oseberg ship showing the deep, blade-shaped rudder. Note the rudder boss and the stout, tapered block of wood reinforcing the gunwale where the rudder neck is secured by means of an adjustable, braided leather band. (University Museum of Cultural Heritage, University of Oslo, Norway)

strakes that rise up almost at a right angle from it. It is this feature that gives the ship its low-slung, rakish lines, but such low sides would also have made it extremely prone to swamping in rough seas.

All joints in the strakes are scarfed, although not all of them have the exposed edge of the joint facing aft as they should. In addition, some 'piecing' is evident around the bow and stern, but internal reinforcements at these points are sound enough to withstand any potential weakness to the hull.

The garboard strake is nailed to the keel, and strakes two to eight are lashed with whalebristle to the ship's 17 evenly spaced ribs by means of corresponding rows of pierced cleats, which stand proud along the inside face of the strakes. Trimmed smooth on their upper sides, the ribs have a ridge on their lower edge, which is pierced to accommodate the spruce lashings running from the strake-cleats. The ninth strake and the *meginhufr* are riveted to the upper section of the ribs by means of trenails. The *meginhufr* also acts as a point of contact for the crossbeams that span the ribs. Vertical props, which are mortised to the underside of the beams and cut to fit over the ribs below, support these. The eleventh and twelfth strakes are secured by rivets to knees, which in turn are riveted to each end of the crossbeams and further strengthen the ship's hull. The twelfth strake forms the gunwale and is pierced with 15 circular oar holes. Each of these has an upward, aft-facing slot through which the blade of an oar can pass, allowing the oars to be put out from the inside of the ship. No slot exists in the hole nearest to the bow, however, as the narrow structure of the ship would not allow an oar to be manoeuvred from the inside. The oar holes are unshuttered, an indication that the ship was never intended to weather heavy seas.

The shield rack is formed by a thin pine batten that runs along the outside face of the gunwale. It is held in place by a number of projecting cleats that create a series of gaps into which the ship's shields could be slotted. This is arranged in such a way so as not to cover the oar holes, and means that the ship could be rowed with the shields in place.

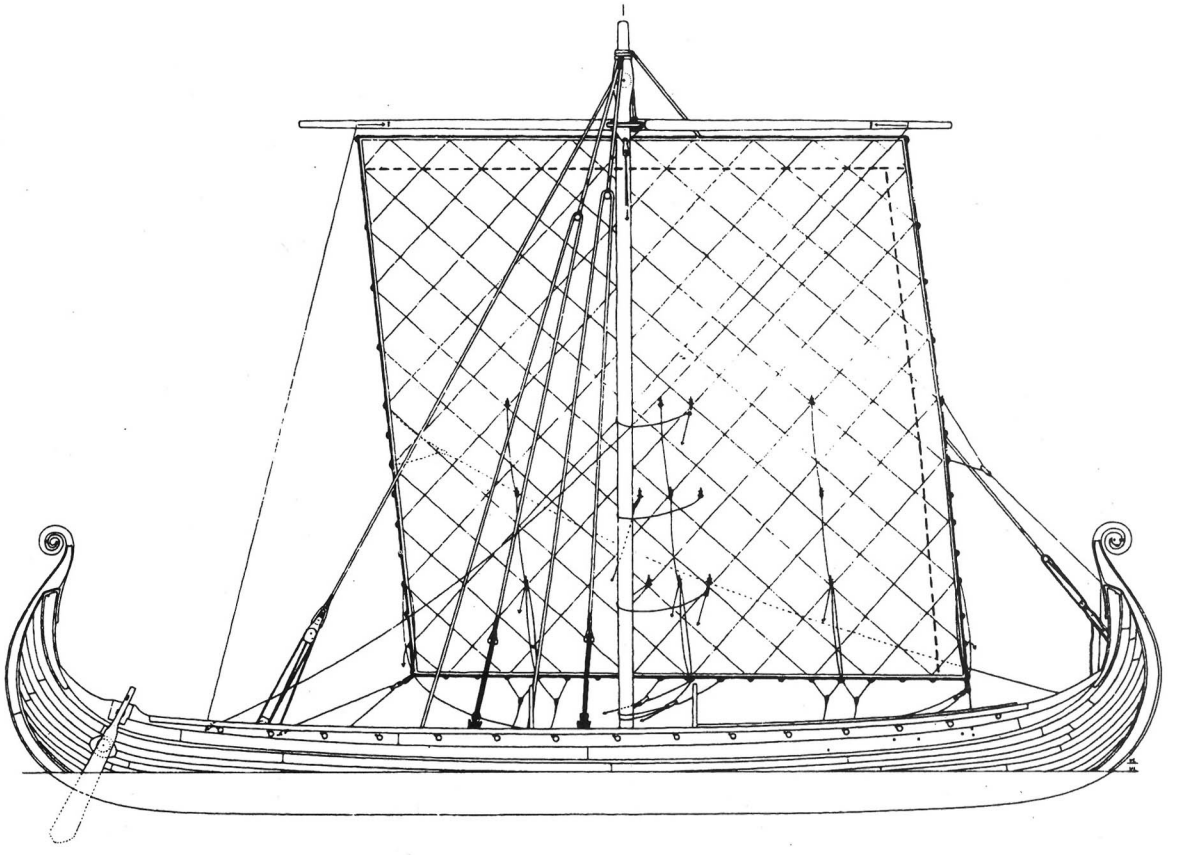
The ship's decking is constructed from pine planking between 2 and 3 centimetres thick. With the exception of the planks at the bow and stern and on each side of the mast, the decking is nailed fast to the crossbeams. Such limited access to the space below decks further reinforces the theory that the ship was not designed for long and arduous voyages.

The mast is of pine and is estimated to have been around 12–13 metres high. The keelson, in which the boot of the mast rests, lies over the keel but is not attached to it. Short and relatively insubstantial for a vessel this size, it extends over only two of the ship's ribs and is supported on each side by two cleats. The socket that accommodates the mast has a rounded fore section, while aft it is cut square, a simple but ingenious feature that facilitates the raising and lowering of the mast, but gives it a secure seating when under sail. Immediately in front of this socket, the timber of the keelson rises in a vertical arm, which not only guides the mast into the socket, but also acts as a brace where it leaves the keelson and passes through the mast-fish at deck level. Although it extends over four crossbeams, the mast-fish, like the keelson, is quite a frail structure. In an attempt to strengthen it, the mast-fish is formed in an arch running fore to aft, and is supported by the crossbeam in front of the mast, which curves up above deck level to meet it. This arrangement, although giving

heightened support to the mast, had only proved partially successful, as the mast-fish had cracked, presumably from the strain exerted upon it when the ship was under sail, and had been repaired with two iron bands. While the fore-end of the mast-fish is closed and solid, there is a deep groove aft, in which the mast would rest when lowered. When the mast was raised, the groove would be filled by a tightly fitting oak chock.

A long piece of timber measuring 12.5 metres was found with the ship, and, based on its proportions, some believed it to be a yard. A rakke, which would have held it to the mast, was also discovered. No sail, however, was found with the Oseberg ship, and any notions as to rigging arrangements can only be tentative. Fore- and backstays were almost certainly employed to raise, support and lower the mast, and although there is no evidence of permanent fixtures for supporting shrouds, these may have been secured through holes that had been bored through the ship's knees. No doubt cordage from the yard and the lower corners of the sail, the clews, was fastened to cleats fixed aft of the third and fourth ribs.

The oak rudder is attached to the ship's starboard side by means of a flexible withy, in this case of pine roots, that is threaded through the rudder and the conical outboard block, then lashed inboard through three holes bored in the rudder rib. The neck of the rudder is held in place at the gunwale by a plaited leather band. In order to withstand the considerable strain caused by operating the rudder, the gunwale is reinforced at this point by a solid block of oak that tapers gracefully towards the stern. There was, however, no trace of a tiller.



This drawing gives a good impression of the standing and running rigging that was probably employed on the Oseberg ship. Although conjectural, it is based on sound experience gained from archaeological evidence and from rigging tested on replica ships. Note the shrouds, bowline and halyard. (Erik Andersen/Søren Vadstrup)

Fifteen pairs of oars were also found on board the ship. They vary in length from between 3.70 and 4.03 metres in order to accommodate the curve of the ship's hull and the varying distances to the waterline. The looms feature delicately painted designs and taper to finely bevelled, leaf-shaped blades. When not in use they would be stored in the two pairs of large wooden forks attached inboard to each side of the ship.

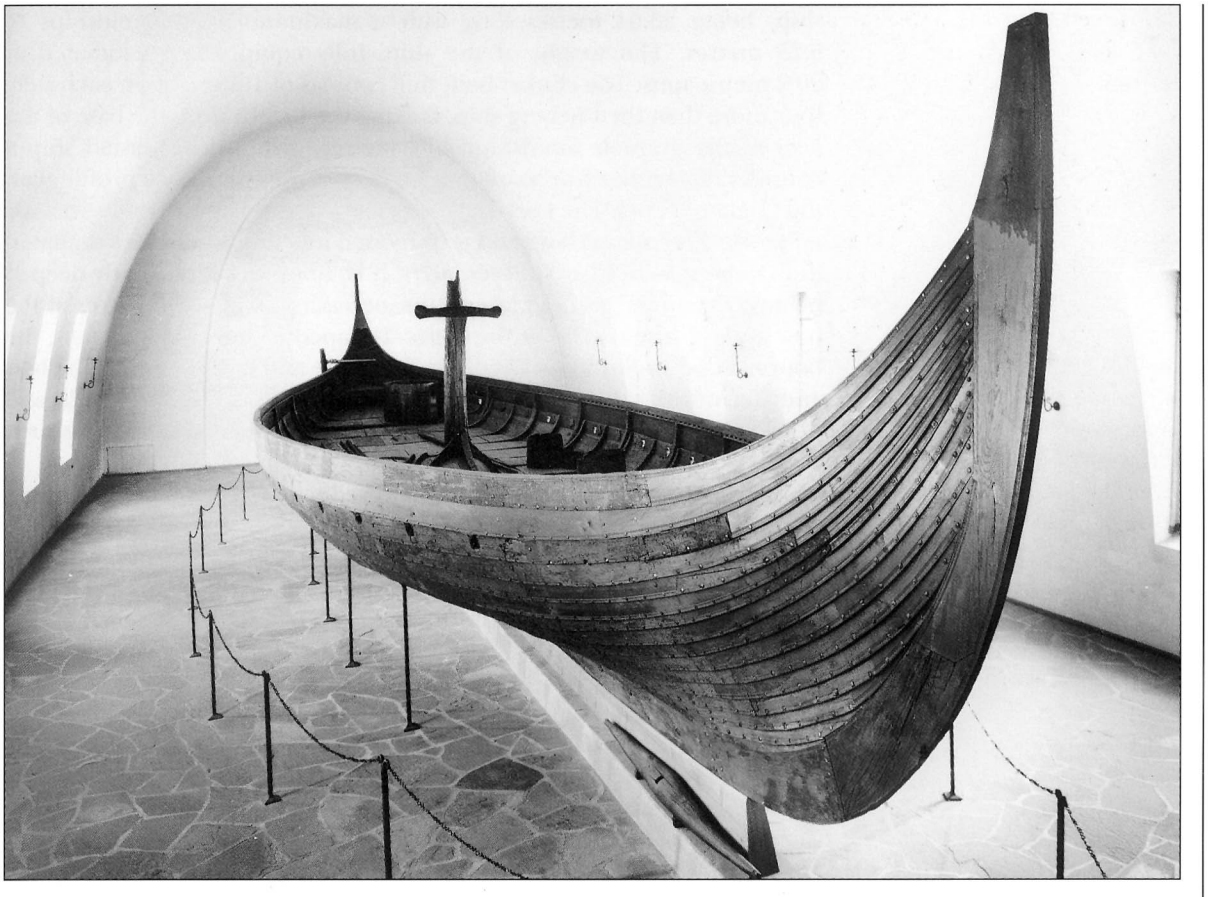
Because there is no evidence of fixed rowing benches on board we can assume that the crew sat on sea chests to row. The dimensions of at least one chest on the ship make it ideally suited to such a purpose; even the iron nails used in its construction have tin-plated heads to protect against tarnishing from salt water spray. The ship is equipped with a well-preserved iron anchor about 1 metre long and weighing just under 10 kilograms. Along with its oak anchor stock, it is fitted with two rings to accommodate cables, one at the top of its shaft and the other between its flukes. Although gracefully made, it is very slight and on its own would never hold fast a ship of this size. One theory has it that when the ship was made fast ashore, such an anchor would be used to keep it clear of land or other vessels.

A pine gangplank nearly 7 metres long and 30 centimetres wide was also found. There is a hole at one end for securing it to the ship, and the upper surface is deeply ridged to assist purchase. The ship was also equipped with a long-handled baler, buckets, a large copper cauldron for cooking and a water cask.

Finally we come to the prow and stern. Formed in lavishly carved, soaring arches, they tower 5 metres above the waterline, and terminate in elegant, serpentine spirals. Not only do they give the Oseberg ship its essential character, they also confirm its status as the finest expression of artistic endeavour yet discovered from the Viking Age. Both sides of the prow and stern are decorated with a frieze of fabulous beasts. The carving, in the style of the period, is of the highest order. At the point where the arch becomes a spiral the design becomes simpler, the lines imitating a serpent's body and terminating in the creature's head at the prow and its tail at the stern.

Where the transition to prow and stern begins, the gunwales – which at this point are made from beechwood, the only part of the ship's structure which is not oak – broaden as they rise and feature panels carved with the same beasts that decorate the prow and stern. These sections are known as '*brander*', and inside the sharp angle created where they meet are two braces which are carved in the same style. The upper of the two is triangular, and is known as the '*tingl*', while the lower, a transverse bar, is known as the '*spån*'.

As we have seen, elements of the Oseberg ship's construction would have prevented it from safely crossing the open sea. Some scholars have attributed this frailty to the kind of tentative design that might be expected in a transitional stage of development. There may well be some truth in this. We know, however, that before the Oseberg ship was even built, Viking shipbuilders had already developed vessels that were quite capable of crossing the North Sea, as monks on Lindisfarne found out to their cost in AD793. It would appear, then, that the Oseberg ship was built specifically for short, fair-weather voyages in Norway's sheltered waterways and that a more robust construction had perhaps been sacrificed to create a spacious pleasure craft to be used on special occasions – a luxury status symbol for a queen.



A masterpiece of construction, it is difficult to imagine how Viking shipbuilders could have improved on such a timeless design as the Gokstad ship. Note the ship's roomy interior and the transitional piece where the keel meets the prow. (University Museum of Cultural Heritage, University of Oslo, Norway)

The Gokstad Ship

Although lacking the more intricate decoration of the Oseberg ship, the Gokstad ship is still a masterpiece of the Viking shipwright's art. With its hallmark design of uncluttered lines and rustic accuracy, it remains one of the most sea-worthy vessels ever built.

The ship lay under a mound 43.5 metres in diameter and 5 metres high, near the Gokstad farm in Vestfold, not far from Oseberg. It was excavated in 1880 by Nicolay Nicolyasen, and although the grave had been plundered in antiquity, the ship was found to be in a remarkable state of preservation because of the damp blue clay that surrounded it. The burial chamber had been erected aft of the mast and contained the skeleton of a powerfully built man in his early 60s. He had been well equipped for his last journey, being accompanied by 12 horses, six dogs and, most interestingly, a peacock – the presence of which indicates far-flung voyaging or exotic trade connections.

Although the ship was built around AD890, the basic method of construction remains the same as that employed 90 years earlier in the Oseberg vessel. Both ships are in the *karvi* class and were designed primarily for coastal voyaging, but several important differences had evolved which allowed the Gokstad ship to cross the North Sea and even the Atlantic in relative safety.

With the exception of the decking, which is pine, the Gokstad ship is built throughout of oak. The vessel is somewhat larger than the Oseberg

ship, being 23.24 metres long with a maximum width amidships of 5.25 metres. The weight of the ship, fully equipped, is estimated at 20.2 metric tons. The clinker-built hull consists of 16 strakes on each side, four more than the Oseberg ship, making the height from the base of the keel to the gunwale amidships 2.02 metres, giving the Gokstad ship a considerably higher freeboard and more rounded transverse profile than the Oseberg vessel. The keel itself is radially cut from a straight-grown oak, measures 17.6 metres long and is fashioned in a similar manner to that in the Oseberg ship, in a flat, even arch. It is, however, significantly deeper, being 37 centimetres high amidships increasing to 40 centimetres at the bow and 42 centimetres at the stern. T-shaped in transverse section, the bottom edge amidships is 13 centimetres wide and tapers towards the bow and stern, while the upper projecting ridge is 20 centimetres wide and provides a broad, stable base for the hull. Even in heavy seas, such a sturdy well-balanced keel would allow the ship to perform a wide range of manoeuvres while under sail and would reduce the chances of swamping or capsizing.

Fore and aft, the keel is scarfed to two transitional pieces, which in turn are secured by scarf joints to the prow and stern. Here, the projecting upper ridge of the keel transforms into a rabbet to which each of the strakes are secured. The upper sections of both the prow and stern are incomplete – they protruded above the bed of clay in which the ship rested and as a consequence perished with the passage of time. Although we cannot be sure how they terminated, it is noticeable at the bow and stern that the inner curve is interrupted by a sharply rising section, while the outer edge follows on in the same graceful line, possibly making the stem and stern posts wider as they rose to their points of termination. It is equally possible, however, that the prow and stern terminated in a point, which would have been formed if the shipwright followed the sheerstrake into the rear edge of the stem and stern.

From the keel, the first nine strakes below the waterline are flexible, being generally 2.6 centimetres thick. The garboard strake is nailed to the keel, and by means of their integral pierced cleats, strakes two to eight are lashed to the ribs with fine spruce roots, while the ninth strake is secured to the ribs by trenails. The transitional tenth strake, the *meginhufr*, is 4.4 centimetres thick amidships and is also fastened to the ribs and crossbeams with trenails. The Gokstad ship has 19 ribs, all hewn from naturally curved oak limbs. The last ribs fore and aft are fashioned as bulkheads, their sides cut in steps enabling a flush fit where they are nailed to the ship's strakes. The bottom section of each bulkhead is pierced to allow drainage, the bulkhead aft also serving as the securing point for the rudder withy.

The crossbeams which span the ribs are arched on their undersides in order to provide the maximum support for the *meginhufr*, their ends obliquely flushcut where they meet the ship's sides. The crossbeams are further supported by a series of vertical props, while amidships, some are supported by the structure that braces and holds the mast.

Carrying the weight of the mast, the keelson on the Gokstad ship is a sturdy piece of timber that rests over the keel and over four of the ship's ribs. It is 3.75 metres long, 40 centimetres high and 60 centimetres wide amidships, tapering fore and aft. As in the Oseberg ship, it is not attached to the keel but in this case is nailed on each side via substantial knees to

The interior of the Gokstad ship. In the foreground is the huge mast-fish with the mast-lock in place. Note the robust, curved knees that secure it to the beams. The oar holes and their shutters can be seen on each side of the hull, along with the knees and top-ribs that support the upper strakes. Note the rebates in the crossbeams to accommodate the loose decking. To the right of the mast-fish are oars, a gangplank, spars and, between two knees, the *beiti-ass* block. (Schwitter, University Museum of Cultural Heritage, University of Oslo, Norway)

the eighth, tenth and eleventh ribs from the stern. The design of the mast-socket follows that of the Oseberg ship and, forward of the tenth rib and the socket, features the same strong, vertically inclined arm, which also supports the tenth beam.

At deck level, the mast-fish had to be strong enough to brace a pine mast 30 centimetres thick and an estimated 13 metres high. Accordingly, it is the largest single component of the ship and is much more robust than that in the Oseberg vessel. Cut from a solid block of oak and

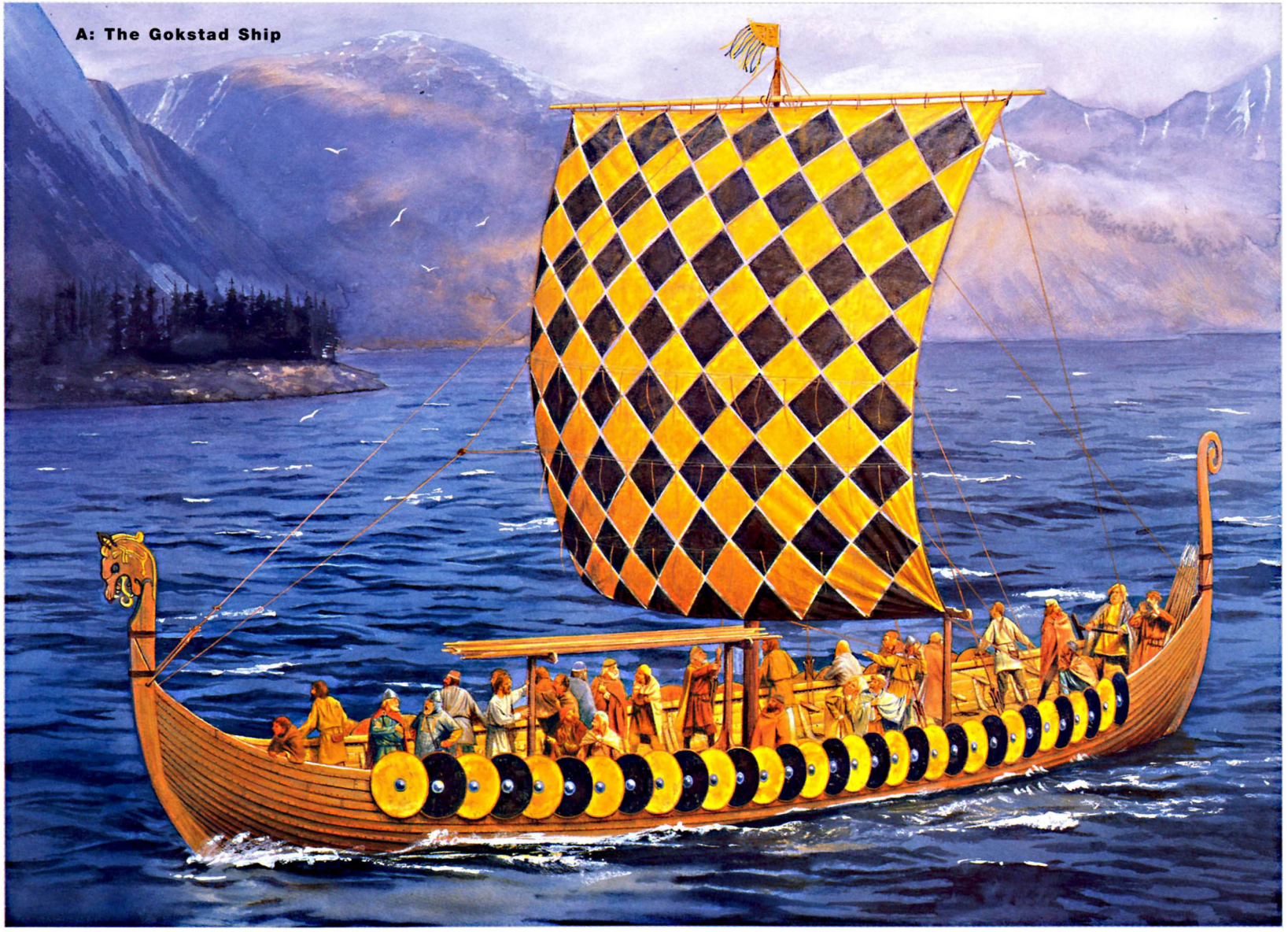
weighing around 4 tons, it is steeply arched, tapering fore and aft to its characteristic fish-tailed shape. It is approximately 5 metres long and spans six crossbeams, into which it is mortised. At its centre it is 1 metre wide, 42 centimetres thick and on each side is made fast to the crossbeams by way of four substantial knees. The mast-fish is further supported by the ninth crossbeam, which, formed like a vertical plank, is supported by the rib below it. As in the Oseberg ship, the mast-fish is forked aft, forming a slot into which the lowered mast could rest. When raised, the slot could be plugged by a remarkably tight wedge – all in all, a firm and secure supporting structure for the mast.

As befitting an ocean-going vessel, the Gokstad ship is high sided, having six strakes above the waterline. The first four of these are braced inboard by strong knees to which they are trenailed, the knees themselves being nailed fast to the crossbeams. The first three of these strakes are about 2.6 centimetres thick, the fourth being slightly thicker at 3.2 centimetres in order to accommodate the oar holes. There are 16 of these on each side, one pair between each of the ship's ribs, excepting the space between the extreme ribs fore and aft. The ribs are spaced 1 metre apart, thus allowing the perfect distance in which to produce the maximum oar stroke. The oar holes are about 40 centimetres above the decking; as there is no evidence of rowing benches, and assuming that the oarsmen sat on sea chests, this would be a comfortable height at which to pull oars. The oar holes, like those in the Oseberg ship, are slotted to allow oar blades to be deployed from the inside of the ship, but on the Gokstad ship they can be closed by means of neatly contrived, circular wooden shutters, a sure sign that this ship was expected to cope in rough seas.

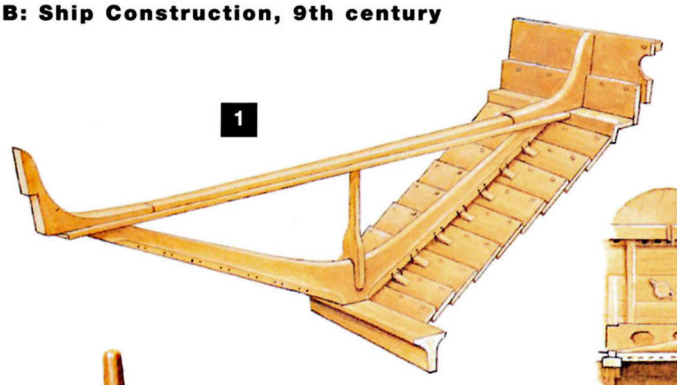
Above the fourteenth strake the two uppermost strakes are trenailed to a series of additional top ribs, one for every other knee. For additional support, these ribs are butted into the gunwale and also extend down over the previous three strakes, to which they are firmly nailed. Immediately below the gunwale inboard, a batten with 11 rectangular openings between each rib runs along the ship's side and forms the shield rack. The Gokstad ship was found with 64 shields, which were tied in place to the shield rack with bast cords. Covering the oar holes and painted alternatively black and yellow, there are 32 on each side of the ship, 2 overlapping shields to each oar hole. Although the sagas decree that sailing with shields hung out in this manner was at variance with tradition, many depictions of ships on the Gotland picture stones seem to contradict such advice.

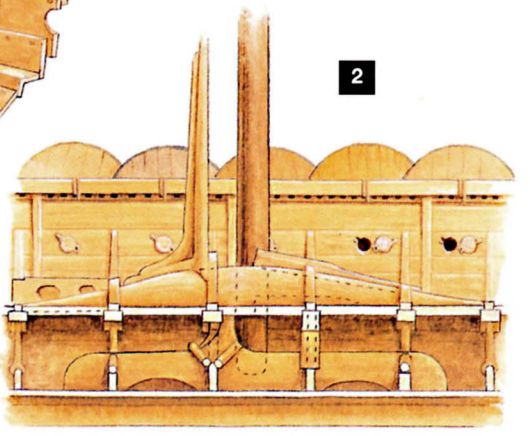
Also present on the upper strakes and secured inboard are three pairs of wooden cleats. These are spaced on both sides of the ship between the first and fourth ribs from the stern and would no doubt have served as convenient points for making fast the braces, sheets and other cordage that constituted the ship's rigging.

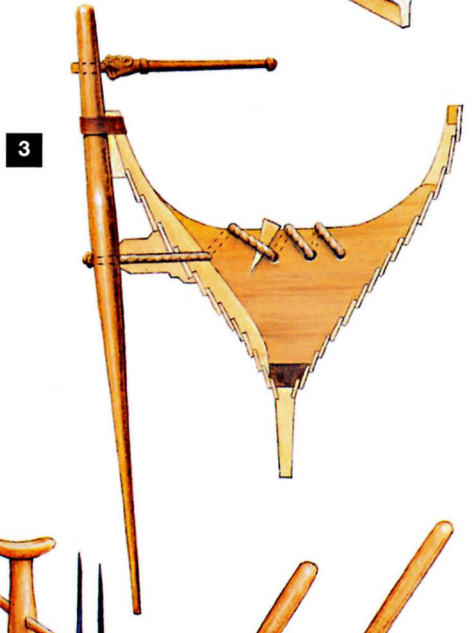
Unlike the Oseberg ship, the pine decking planks are not nailed down, but rest snugly on the crossbeams, which are rebated to receive them. This arrangement allows all the space beneath the deck to be easily accessed for baling and for the storage of weapons and provisions, and is a further indication that the ship was designed with long-range voyaging in mind. Immediately above deck level and forward of the mast inboard, there are on each side of the ship two rectangular blocks fixed securely between the

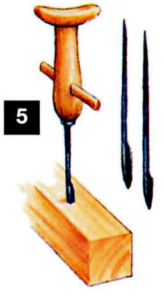

A: The Gokstad Ship

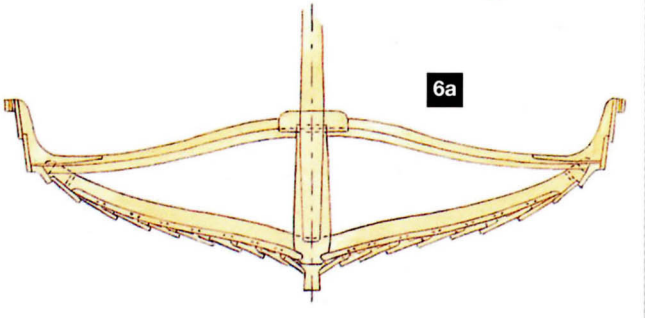
B: Ship Construction, 9th century

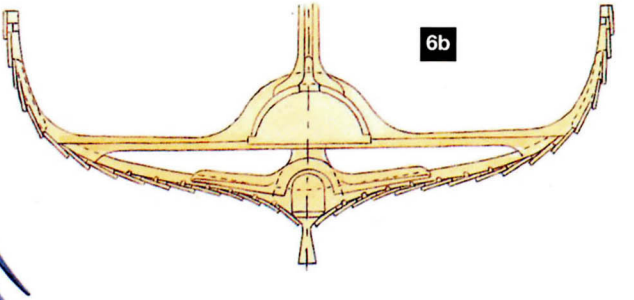


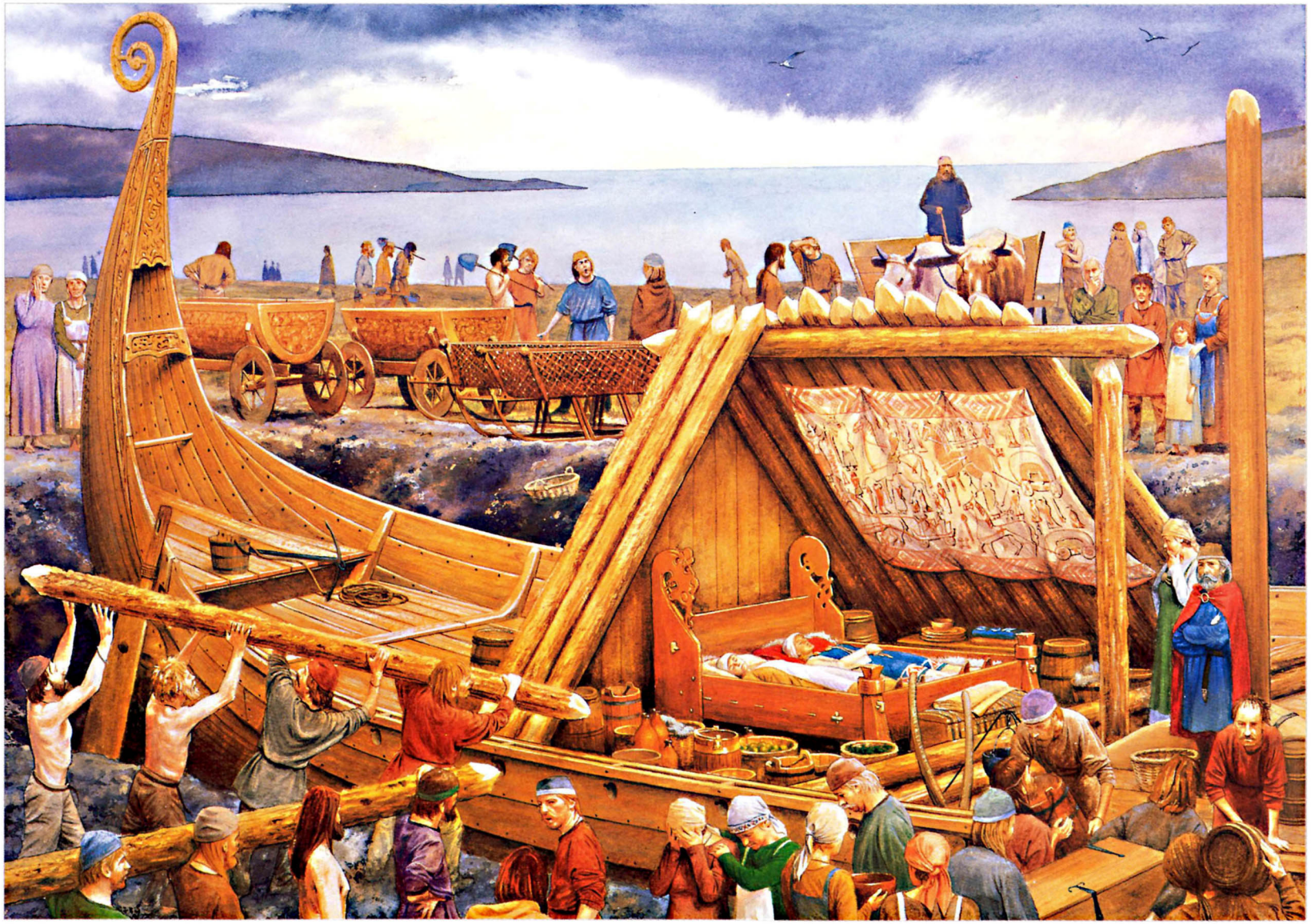












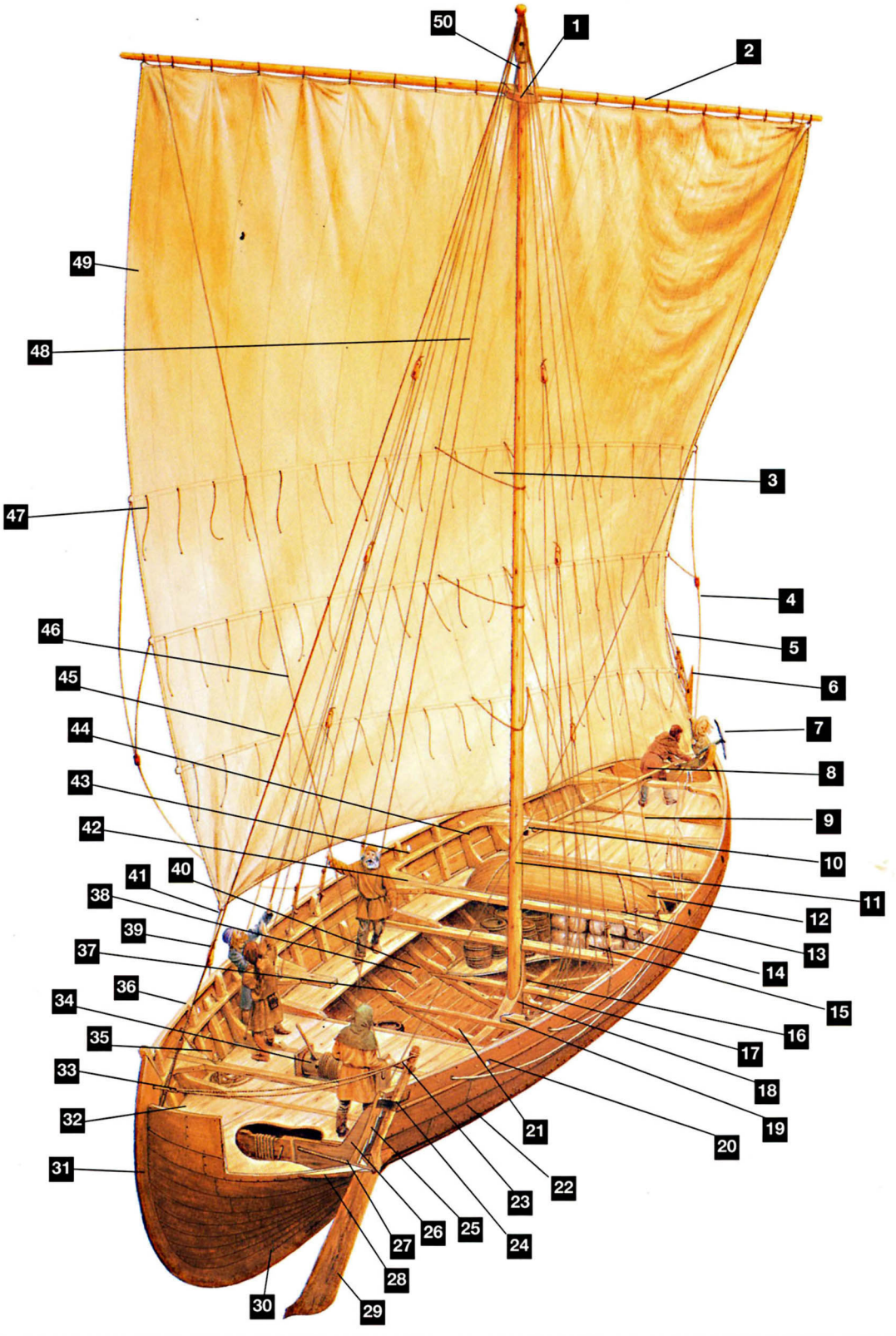
C: The Oseberg Ship

D: A *KNARR*, 11TH CENTURY

KEY

1 Rakke
2 Yard
3 Bunt line
4 Bowline
5 Fore-stay
6 Stem
7 Anchor
8 Beiti-ass
9 Shroud
10 Beiti-ass block
11 Mast
12 Ships boat
13 Additional crossbeam
14 Shroud pin
15 Mast beam
16 Mast step
17 Keelson knee
18 Keelson
19 Lower crossbeam
20 Oar-port
21 Floor timber (rib)
22 Strake
23 Tiller
24 Rudder band
25 Strengthening block
26 Rudder rib
27 Rudder withy
28 Rudder boss
29 Rudder
30 Keel
31 Stern
32 Deck
33 Takke
34 Windlass
35 Belaying pin
36 Gunwale
37 Vertical beam knee
38 Side timber
39 Block
40 Hold
41 Sheet
42 Horizontal knee
43 Longitudinal stringer
44 Vertical knee
45 Back-stay
46 Brace
47 Reefing point
48 Halyard
49 Sail
50 Mast-head

NB In addition to cargo, Norse vessels would invariably carry some form of ballast. In order to show the interior of the ship clearly, this has been omitted from the illustration.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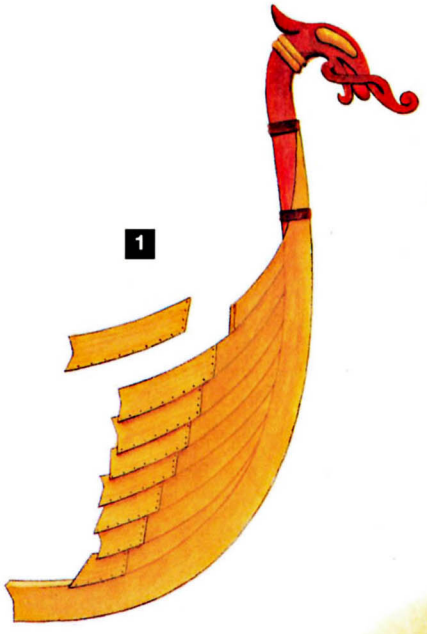
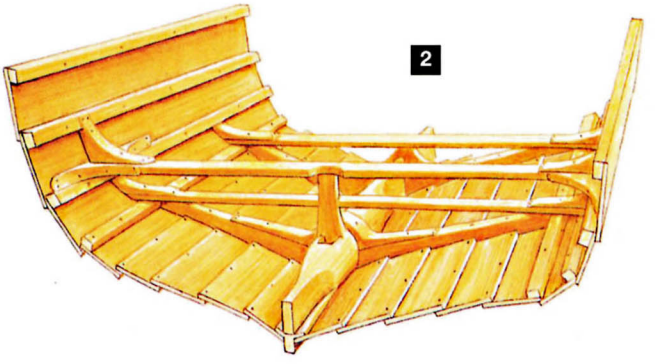
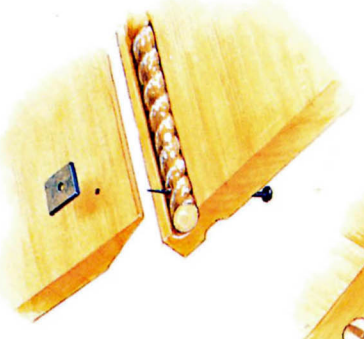
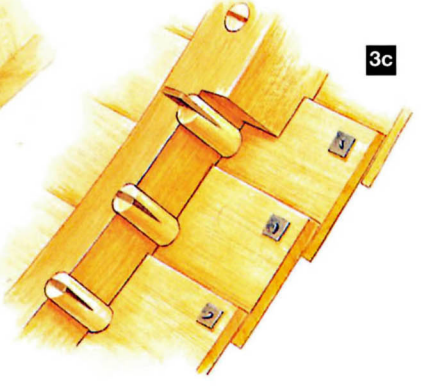
E: Russia, AD950–1000

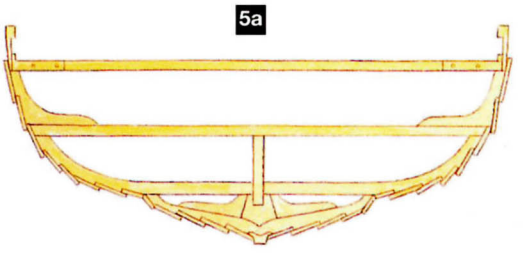
F: Ship Construction, 11th century

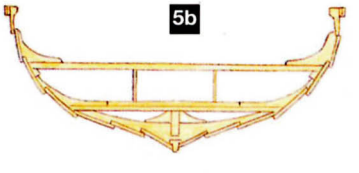












G: The *Mora* and the Norman invasion fleet

seventh and eighth rib from the bow. They are deeply recessed and for many years their significance remained a mystery. It is now apparent that they served as supports for a spar or *beiti-ass*, the base of which could be jammed into the recess at a variety of angles, the top being lodged wherever appropriate on the ship's sail, keeping it taut and maximising the spread of canvas when tacking. No sail was found on board, but based on the likely dimensions of the mast and yard, it has been estimated at 70 square metres.

A number of spars were found, along with some cordage, blocks and tackle, but we can only make educated guesses as to rigging arrangements.

Apart from its sailing activities, the strength of the Gokstad ship lay in its oar power. The design of the hull is such that the gunwale runs parallel to the waterline for most of its length, thus allowing the maximum number of oars to strike the water in unison, and whether engaged in piracy or raiding, the speed generated by 32 powerful, experienced oarsmen would have given a substantial advantage over pursuing forces or lesser craft. As the ship is quite capable of carrying 60 or 70 men – a double crew – it is likely that while half rested, the others rowed. The oars, which were discovered in the bow, range in length from 5.30 to 5.85 metres to suit their station on board ship. Made of pine, they have slender looms that taper towards the handles, and small, lancet-shaped blades.

Also above deck level are three T-shaped posts. One of these is situated midway between the mast and stern and another midway between the mast and prow. These two extend below deck to the keel, where they are secured by two cleats. The third post, immediately in front of the mast, is nailed securely to the mast-fish. The three posts are about 2.4 metres high above the deck and a little over 4 metres apart. As we have seen, the ship's oars have an average length of about 5.5 metres, and it is fairly certain that when not in use the oars, and perhaps the yard, would have been stored across these posts, keeping them well clear of the deck.

At the stern there is a small raised poop-deck for the helmsman, and fitted starboard aft is the ship's blade-like rudder. Cut from a single piece of oak, it is 3.3 metres high, and 42 centimetres wide. It also extends 50 centimetres below the keel amidships and would have helped prevent sideways slippage when tacking. The lower aft edge terminates in a slight curved heel and is fitted with a small metal clamp. To this would have been tied a rope that would have allowed the rudder to be raised while in shallow water. The rudder is attached to the ship in the same manner as in the Oseberg vessel, although where it is in contact with the hull, strengthening measures have been considerably increased. The strain on the rudder withy could be quite severe when the wind was to starboard and when to port, the band around the rudder neck could also experience considerable strain. To counter this, a solid oak block pointing aft has been nailed to the rudder rib and to the ship's side inboard where the rudder withy passes through the hull. In addition, where the rudder band passes inboard, a stout plank 10 centimetres thick is nailed to the gunwale outboard and to the strake below it. The rudder neck extends about 50 centimetres above the gunwale and is fitted with a detachable tiller. This is the only decorated object on the ship, and features a small, gaping dragon's head, highlighted in yellow paint and in the act of devouring the spigot.

The ship had been fitted out with an anchor estimated at 1.1 metres long, a pine gangplank 7.4 metres in length and a cask which would hold 750 litres of fresh water. Also interred with the ship were three exquisite smaller boats, six collapsible beds, a tent with decorated verge boards, a large bronze pot and various kitchen utensils.

SHIPBUILDING IN THE 11TH CENTURY

As we have seen in the Gokstad ship, Viking shipbuilders were well able to construct a single vessel that would meet the needs of both pirate and trader. However, after a unique salvage operation at Skuldelev on Roskilde Fjord in Denmark, we know that by the year AD1000 a marked distinction had been established between warships and merchantmen, and that construction methods had evolved accordingly.

In 1962 Danish archaeologists uncovered and retrieved the submerged remains of five very different kinds of vessels, which in the 11th century had been scuttled in a narrow stretch of the fjord, creating an underwater blockade to thwart a seaborne incursion on the thriving town of Roskilde. A showcase of Viking shipbuilding skills, the find consisted of a longship (*skei*), a small warship (*snekkja*), a coastal trader, a small cargo boat and an ocean-going merchant ship (*knarr*), all of which shared the same basic construction.

The ships were still clinker built, but shipwrights had dispensed with the system of lashing the ship's strakes to the ribs in favour of trenails, by which they were now secured, thus creating a more rigid structure. The mast-fish too had disappeared, being replaced by a strong crossbeam that was pitched higher than its fellows, supporting the mast and bracing the ship's sides, to which it was secured by vertical and horizontal knees. Above the waterline, top ribs had also disappeared and for most of their length upper strakes were now reinforced by longitudinal stringers. The crossbeams were still secured by trenails to the tops of the ribs and by knees to the sides of the hull. Also, some of the ships had additional

An English longship as portrayed in the Bayeux Tapestry. Note the kite-shaped shields hung inboard and the break in the gunwale line that may have facilitated loading. The mast is supported by shrouds, a forestay and a backstay. The ship tows a boat similar to those found in the Gokstad burial. (The Bayeux Tapestry, 11th century. By special permission of the City of Bayeux)

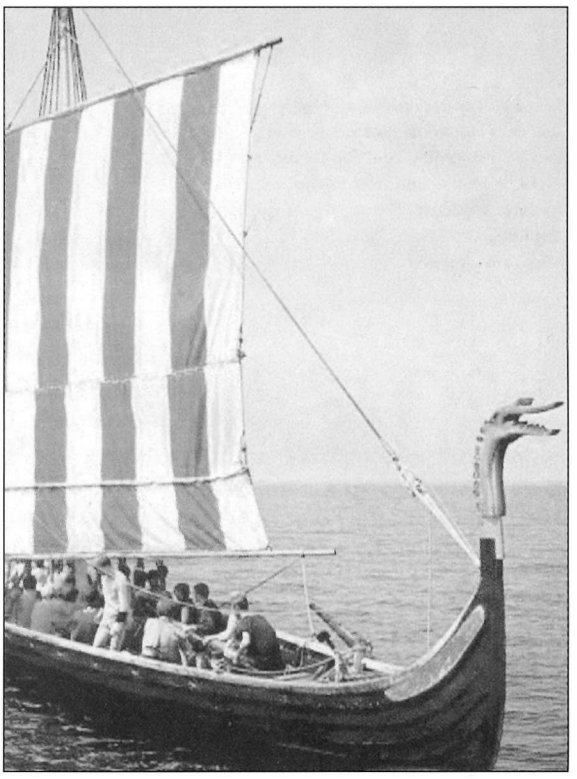
crossbeams permanently secured above deck level, which would have accommodated oarsmen.

The small coastal trader also yielded intact a slender and skilfully fashioned prow. Hewn from a single piece of timber, its carved lines follow the form of the curving strakes that meet it and imitate their clinker-built construction. It is interesting to note that in addition to oak, a variety of wood types such as lime, ash, willow, birch and pine have been used in the construction of these vessels, an indication perhaps that suitable oaks were becoming hard to find.

The Longships

By the beginning of the 11th century, Scandinavian monarchs began building large warships. They also instigated the *ledungen*, by which every district under the king's domain was obliged to build ships for the sole purpose of warfare and to provide militia to crew them. The primary function of these ships, large and small, was to transport as many fighting men as possible to a point of conflict and to do it rapidly, without having to rely on favourable winds. This gave rise to the true Viking warships or *langskips*. Long and narrow, often with a length-breadth ratio of 7:1, their speed while under sail or being propelled by large numbers of warrior/oarsmen was formidable. Longships varied considerably in size and tended to be classified by the number of spaces between deck beams (*rum*) or the number of paired rowing places (*sessa*) making a ship with 30 oars a *fimtansessa* (15-bencher). The 10th-century Gulathing Law tells us that a *threttansessa* – a ship with 26 oars – was the smallest that could be 'counted by benches', indicating that smaller vessels were unsuitable for military purposes. The majority of Scandinavian levy ships appear to have been 20- or 25-benchers, but smaller ships were undoubtedly called into use when the need arose.

Near the end of the 10th century we see the emergence of a number of giant longships or *drekar*, including King Olav Tryggvasson's '*Long Serpent*' that sported 34 benches. In 1062 Harald Hardrada launched a 35-bencher appropriately named '*Great Dragon*'. It is described as being 'much broader than normal warships; it was of the same size and proportions as the "*Long Serpent*" and each part was built with great care. On the stem was a dragon-head, and on the stern a dragon-tail and the bows of the ship were gilded. It had thirty-five pairs of rowing benches and was large (even) for that size of vessel.' The first longship to be discovered, however, was somewhat smaller.



The '*Imme Gram*'. A Danish copy of the Ladby ship. Under her red and white striped sail, this dragon-prowed replica epitomises the popular concept of a Viking ship. (Courtesy of the Imme Gram Association)

The Ladby Ship

This ship, found in 1935, was unearthed from a chieftain's burial mound on the island of Funen in Denmark. Only the ghostly imprint of the ship remained, the impression of the hull being marked by rusted nails and dark stains in the soil. The vessel proved to be 20.6 metres long and only

2.75 metres wide amidships, a length-breadth ratio of 7:1. Compare this to the Gokstad ship's ratio of 4.5:1 and we have a predatory, rapier-like craft with a very shallow draught, the height from the keel to the gunwale being just 65 centimetres. Undoubtedly a warship, the vessel was fitted with a dragon-head, evident from a surviving crest of iron spirals at the ship's prow.

Four large iron rings were also found attached to the ship's ribs amidships and were probably used to secure the shrouds. Academics were sceptical about the seaworthiness of such a vessel and believed that its activities were confined to coastal waters, a theory roundly disproved when the Danes built a replica of the ship, the '*Imme Gram*', and sailed her across the North Sea.

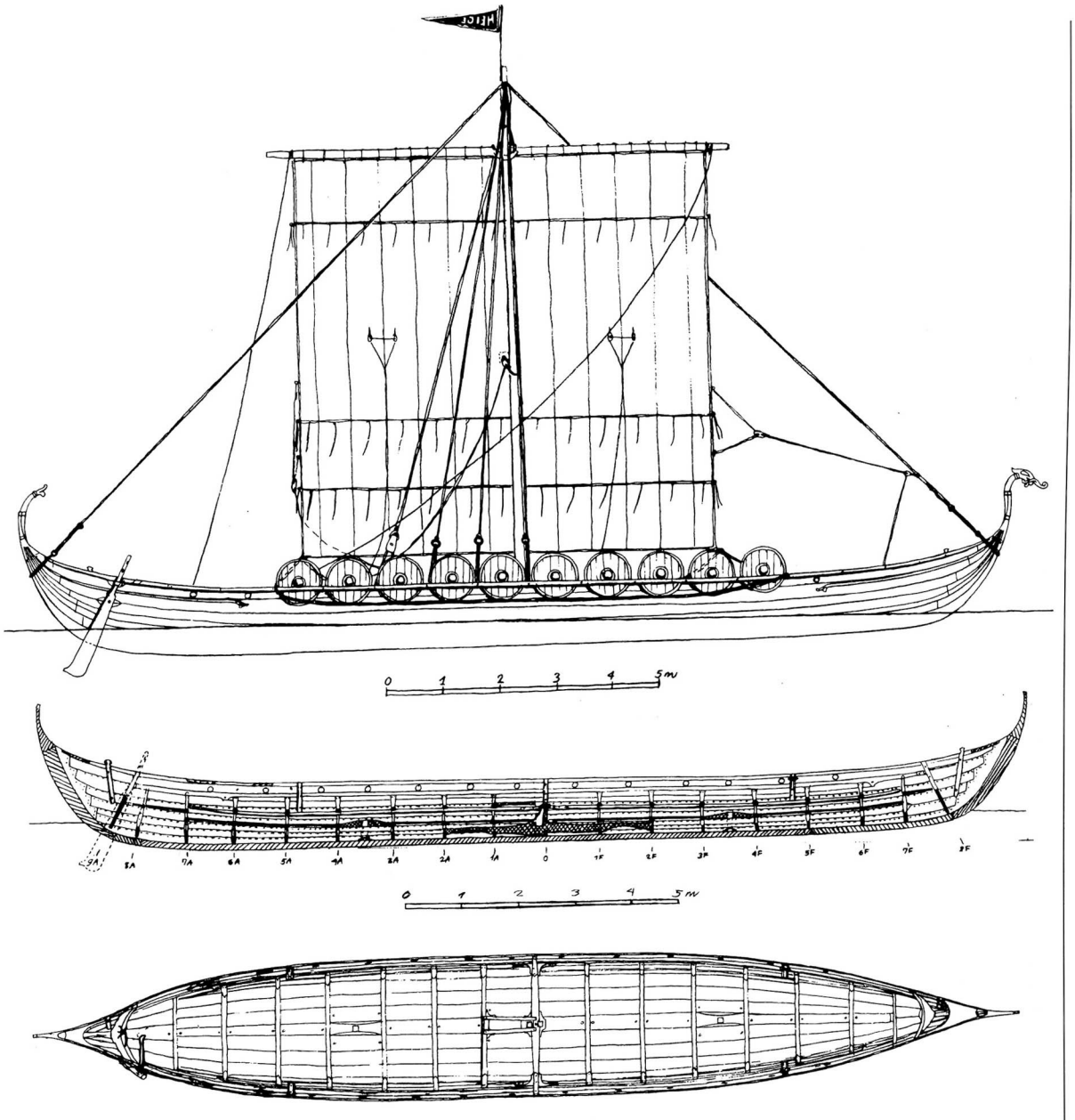
The Skuldelev 5 replica, '*Helge Ask*', on Roskilde Fjord. Her hull is painted yellow and red in the style of ships depicted in the Bayeux Tapestry. (Photo Ole Malling, The Viking Ship Museum, Roskilde)

The Skuldelev Warships

Sharing the same length-breadth ratio, but dating from around AD1040, the small Skuldelev warship known as Skuldelev 5 is 17.5 metres long and 2.5 metres wide. Construction follows the 11th-century pattern, the hull comprising 16 ribs and seven strakes on each side, the first four being oak, the upper three ash. Each rib is spanned by a crossbeam that supports a deck of loose planking level with the top of the third strake. In order to provide benches for oarsmen, a second set of narrow beams were secured 30 centimetres above 13 of the lower beams, the top strake being pierced with a like number of oar holes on each side.

Carrying a crew of 30 warriors, a sail estimated at 50 square metres and deploying 26 oars, this vessel was a fine warship and is no doubt representative of many of the ships depicted in the Bayeux Tapestry.

Along with other ships from the Skuldelev find, a full-scale replica of Skuldelev 5, the '*Helge Ask*', has been constructed by a skilled team of

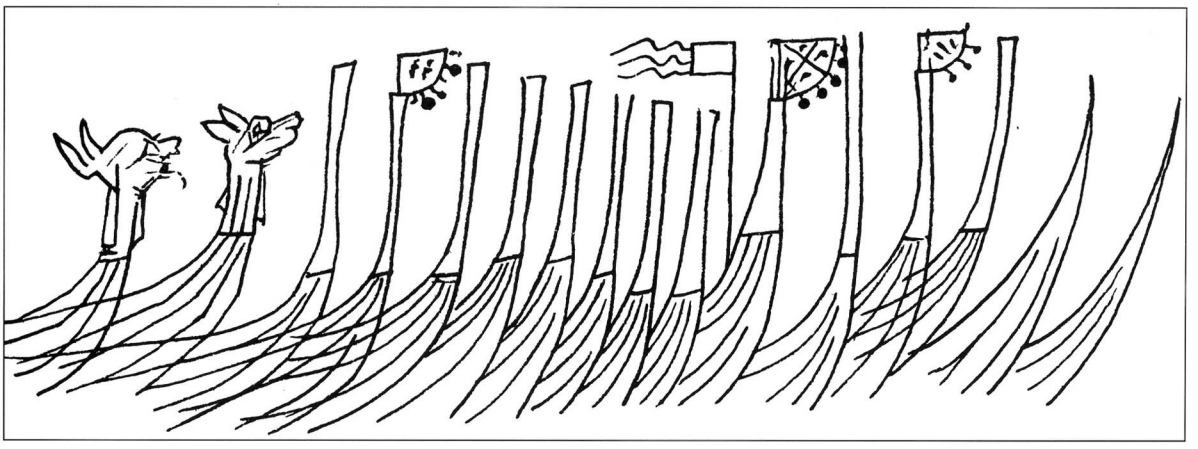


The rigging arrangements and overall dimensions of the '*Helge Ask*'. Note the shield rack and decorated prow and stern. (Courtesy of Søren Vadstrup)

scholars, craftsmen and sailors based at the Viking Ship Museum at Roskilde. Using sound archaeological data and traditional methods of construction, the team relies strictly on tools copied from examples from the Viking period, and by building these replicas and taking them out to sea, they have greatly enhanced our knowledge of Viking ships and seafaring.

Under sail, with a good breeze, the '*Helge Ask*' has reached speeds of 14 knots, and under oar power, even when rowing into the wind, can make a respectable 5.5 knots.

Skuldelev 2, the other warship that was part of the underwater blockade, is a true longship or *skei*. Built of oak, the ship is estimated to

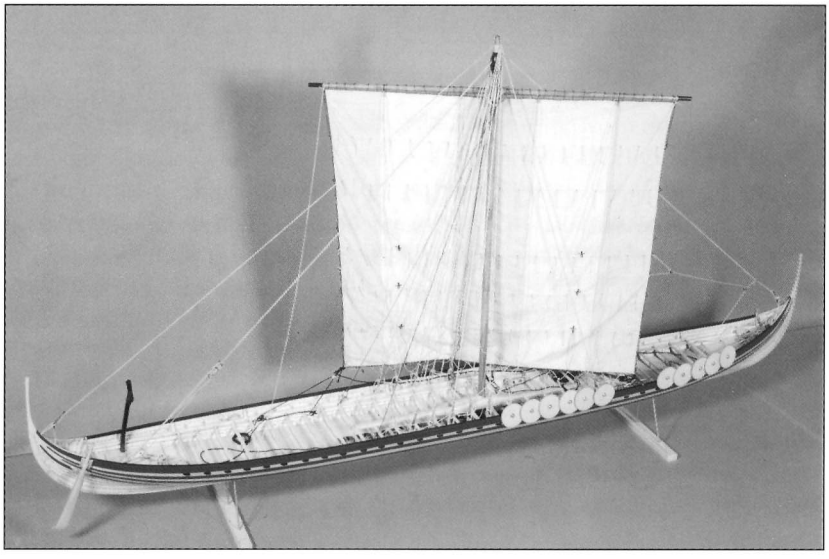


Showing a fleet of Viking ships, this early 13th-century graffiti was incised on to a stick found at Bergen, Norway. Some of the ships carry carved figureheads or weather vanes on their prows, and others, resembling the stem of Skuldelev 3, are elegantly curved. (Drawing, Ian Heath)

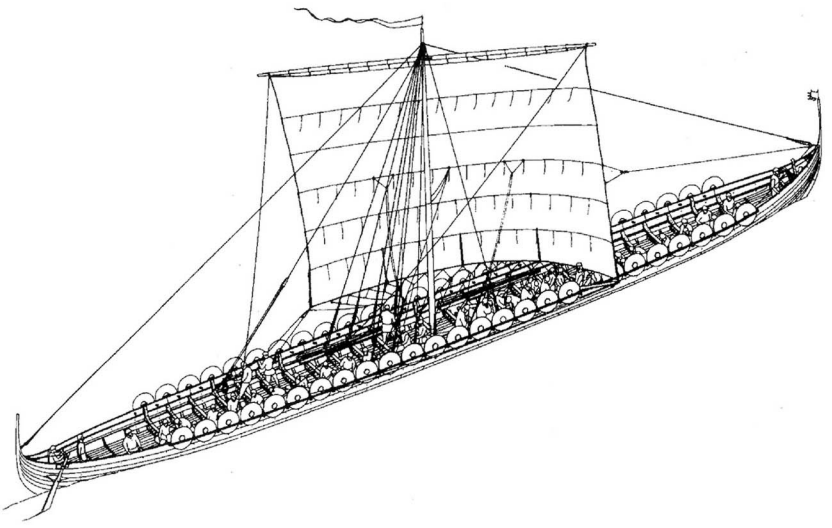
have been approximately 30 metres long and 3.8 metres wide. The ship's strakes, 12 on each side, were only two to two and a half centimetres thick, and the keelson at 13.34 metres long had obviously been fashioned to give longitudinal strength to the hull. Fully crewed, the ship would have held 60 to 100 men and was fitted with between 56 and 60 oars. Under oar power, even over great distances, this ship would have been able to maintain impressive speeds of between five and six knots. Her sail has been estimated at 150 square metres, which with a following wind would have achieved speeds in the region of 20 knots. For all her great length, this awesome longship still retains a draught of only 1 metre, allowing her to cruise the same shallow waters as much smaller craft.

That such great vessels were capable of crossing the open sea was proved beyond doubt when the ship's timbers were subjected to dendroanalysis. Tests confirmed that the ship had been built of Irish oak, probably in the Viking city of Dublin, around the year AD1060, and had made at least one voyage across the North Sea to Denmark. At the time of writing, a replica of the ship is being constructed at Roskilde.

Skuldelev 2 was, until 1997, the longest ship found from the Viking



This splendid model, a 1:10 reconstruction of the vessel known as Skuldelev 2, gives a fine impression of the awesome appearance of a true Viking longship. She was capable of carrying between 60 and 80 warriors/oarsmen, and with a draught of only 1 metre, could strike deep into enemy territory. (Photo Werner Karrasch, The Viking Ship Museum, Roskilde)



Reconstruction based on the remains of a longship that ended its days as a fire-ship in an attack on Hedeby/Haithabu around AD1000. The ship was built in AD985 and has been estimated at 30.9 metres long, 2.7 metres wide amidships with around 58 rowing stations. Note the shield rack and the weather vane at her prow. (Drawing, Sune Villum-Neilson, from *'Viking Age Ships and Shipbuilding in Hedeby/Haithabu and Schleswig'*(Ole Crumlin Pedersen, 1997)

Age. Then the remains of another nine ships were discovered sunk in mud, alongside the actual Viking Ship Museum at Roskilde. One of them, Roskilde 6, has been identified as a longship, being an incredible 36 metres long and 3.5 metres wide, putting it firmly into the class of vessels that gave rise to the '*Long Serpent*' and '*Great Dragon*'. Built around 1025, such a splendid ship would almost certainly be the property of royalty, and it is tempting to link the find to King Canute, who then ruled Denmark, Norway, England and southern Sweden.

The oak keel, T-shaped in cross section and 32 metres long, consisted of a central section and two end pieces to which it was well secured by long scarf joints. Regularly spaced ribs 78 centimetres apart covered the first five strakes, making the upper crossbeams (which have unfortunately not survived) an ideal distance apart for rowing. Light half-frames secured between the ribs gave added support to the third and fourth strakes, the latter of which was strengthened by a stringer on to which the lower beams would have been attached. Only a fragment of the keelson has survived and this rested on the ribs and was secured by horizontal knees.

The ship's sail has been estimated at 200 square metres, and with its 78 rowing stations, this leviathan must have been a breathtaking sight. A true saga-ship, it could easily carry 100 warriors, and without doubt would have had its bellicose image enhanced by a fine dragon-headed prow.

The *Knarr*

To the Norsemen, personal independence was a highly prized commodity, and by the beginning of the 10th century the gradual spread of royal power in their Scandinavian homelands was, to many of them, an unwelcome intrusion into their lives. This factor, along with over-population, blood feuds and a hunger for new lands, became the impetus for an expansion westwards that had already seen Norse settlers well established in the Faroe Islands, the Hebrides, Orkneys and Shetlands. By AD870 the colonisation of Iceland had begun, and between AD985 and AD986, Eirik the Red led the first immigrants ashore on Greenland. Five years later, Leif Eiriksson became the first European to set foot in North America.

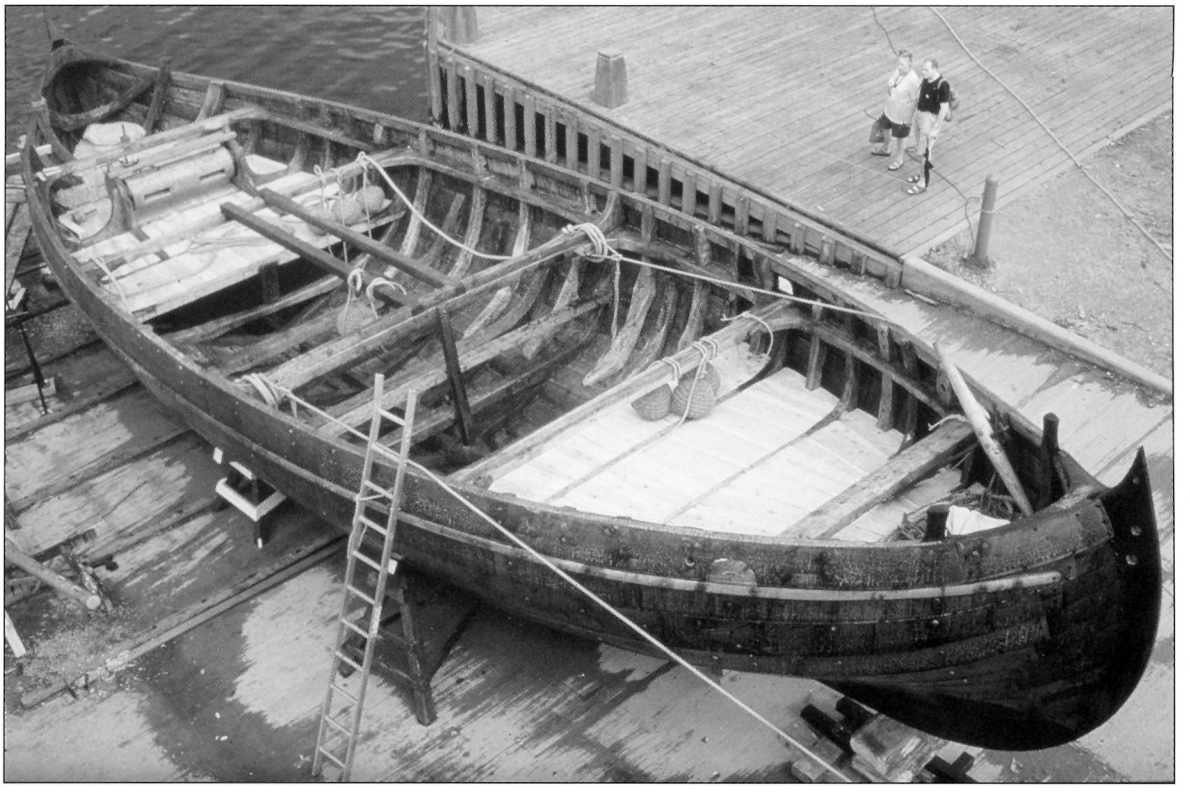
The well-preserved remains of Skuldelev 1. On the forward port side, note the surviving section of the longitudinal stringer rebated into the ribs and below it, the beiti-ass block. (Photo Werner Karrasch, The Viking Ship Museum, Roskilde)

Once settled, colonists needed regular deliveries of essential supplies from their homelands, brought by ships that could also take their exports back to Scandinavia. The ships that made these epic voyages 'west-over-sea' were *havskips* or *knarrs*, the most seaworthy vessels the Norsemen ever produced. High-sided and broad of beam, these vessels relied almost solely on a large rectangular sail for propulsion. In order to weather the heavy seas of the North Atlantic, they were constructed in a suitably robust manner.

Built between AD1030 and AD1050, Skuldelev 1 is a prime example of such a vessel, between 60 and 70 per cent of it being recovered from the underwater blockade. Dendroanalysis has shown that the ship was built in western Norway, probably on the Sognefjord, and was repaired in Oslo Fjord before sailing to Denmark.

The ship is 16.3 metres in length and has a width amidships of 4.5 metres, the height from the keel to the gunwale being 2.1 metres. When fully loaded, the ship's draught would be 1.3 metres. The oak keel is 12.1 metres long, and the sternpost comprised three separate, scarfed pieces. The upper section, which received strakes six to 12, was fashioned in a similar way to the prow on Skuldelev 3, being carved in a way that continues the lines of the strakes. The ship's hull is formed by 12 pine strakes on each side, the fifth from the keel being steeply pitched and marking the transition between bottom and side.

The hull is strengthened by 14 ribs, further support being provided by additional ribs near the prow, stern and aft of the mast.

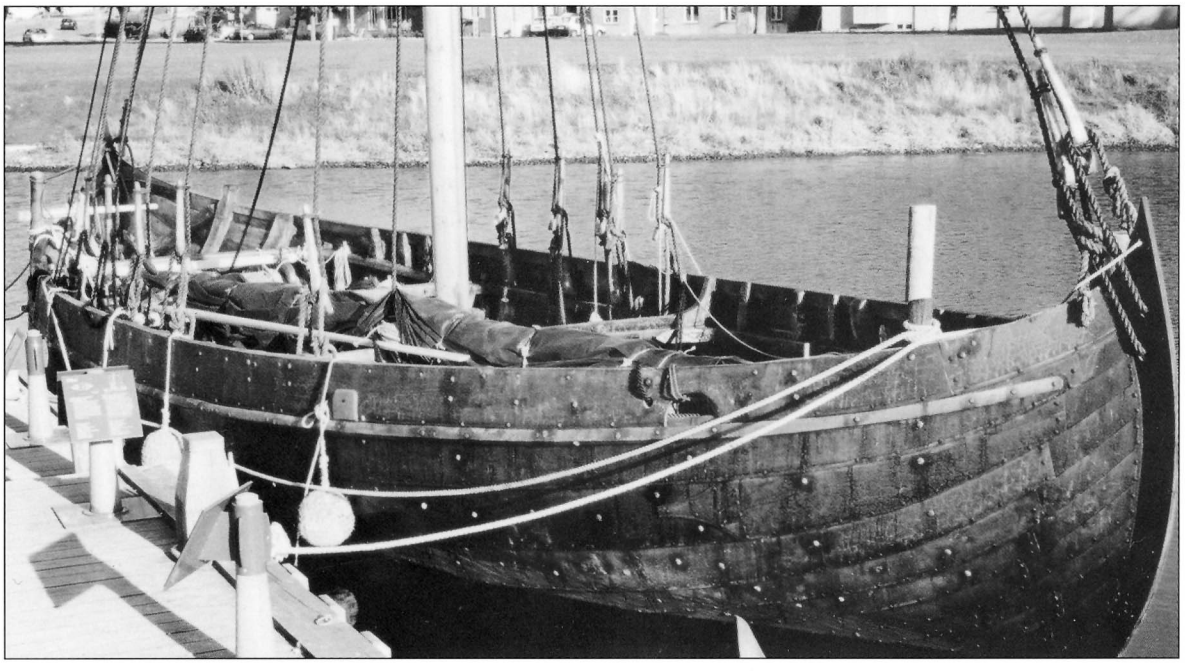


The Skuldelev 1 replica '*Ottar*' under construction at the Museum shipyard, Roskilde. Note the cavernous cargo hold, the curving ribs and the sturdy crossbeams that brace her hull. (Photo Werner Karrasch, The Viking Ship Museum, Roskilde)

Amidships is an open hold of 30–35 cubic metres that would, it has been estimated, accommodate 24 tons of cargo. Here, ribs extend over the first five strakes, and crossbeams are fastened with massive knees that cover strakes six to 11 and, in places, 12. The keelson, which was over 5 metres long, extended over six ribs, the midship rib being immediately in front of the mast-step. Above this, at the level of the ninth strake, a sturdy crossbeam is secured to the knees over which it rests. This, and a robust additional beam above it, level with strake 11, would have helped to brace the mast. Four more of these top crossbeams are also evident, evenly spaced along the length of the ship. For additional longitudinal strength, the upper edge of strake 11 carried a sturdy stringer along its length, which featured horizontal knees on to which the upper crossbeams were secured.

The ship was decked fore and aft, and the crossbeams were rebated to receive the planking. About 3.5 metres forward of the mast at deck level on the port side, a '*beiti-ass*' block 1.25 metres long was found. The block had three well-used recesses cut into it and would have allowed a wide variety of angles for a spar when tacking. It has been estimated that the ship's sail would have been between 80 and 85 square metres, and that she would have required between five and eight men to crew her. The *knarr* would have utilised two or four oars for manoeuvring, and may well have employed a windlass for raising and lowering the heavy yard. As such vessels were too heavy to be beached, a small ship's boat would have been towed or carried on board, in order to ferry cargo to and from shore.

A fine replica of Skuldelev 1, the '*Ottar*', has been built at Roskilde. Under sail in favourable conditions, the ship can easily cruise at 5–6 knots.



Launched in August 2000, the '*Ottar*' is a fine example of an ocean-going *knarr*. Such a ship may well have been owned by a co-operative of merchants who would use her to transport their wares to northern trading centres such as Hedeby and Birka. (Author)

With a strong following wind, however, she has reached maximum speeds of 12.5 to 13 knots.

Between the 10th and 12th centuries, when a *knarr* set out across the North Atlantic, it would have beeen packed with a variety of livestock, provisions, timber, iron and whole families of immigrants and their belongings. As much dried food and fresh water as could be accommodated would be stored on board, for these ships were at the mercy of the wind, and depending on prevailing conditions, the duration of a voyage from Norway to Iceland could be between five and 20 days. Many ships, no matter how seaworthy, set out and were never seen again.

'*Ottar*'s robust construction is clearly evident in this close-up of her stern. Note the tool marks on her hull, the powerful rudder and the windlass that assists in raising the yard and sail. (Author)

Under her full, woollen sail, the '*Ottar*' cruises on Roskilde Fjord. Ample of beam, it is clearly apparent why the sagas refer to these seaworthy vessels as 'swan-breasted'. Ropes employed in the rigging are made from hemp, limebast and horsehair. Note the buntlines running from mast to sail and the sturdy shrouds that support her mast. (Photo Werner Karrasch, The Viking Ship Museum, Roskilde)

Ships could also be blown wildly off course, although on occasion such calamities could lead to the sighting of new lands, as was the case with Bjarni Herjolfsson when he came across the coast of America in AD985.

The compass was unknown, and when out of sight of land the Norsemen would plot a course using the position of the sun and the stars. Much of their skill, however, lay in the observation of natural phenomena and a wide knowledge of the sea itself. Its varied colours would indicate where known currents ran, and the sighting of seabirds and marine life could also give clues as to their position. In addition, this kind of accumulated knowledge would be passed on to those who wished to follow.

Most of their sailing, however, was carried out within sight of the coasts and skerries of their homelands, and these coastal waters must have teemed with a wide variety of small cargo ships. One such vessel is the well-preserved wreck known as Skuldelev 3.

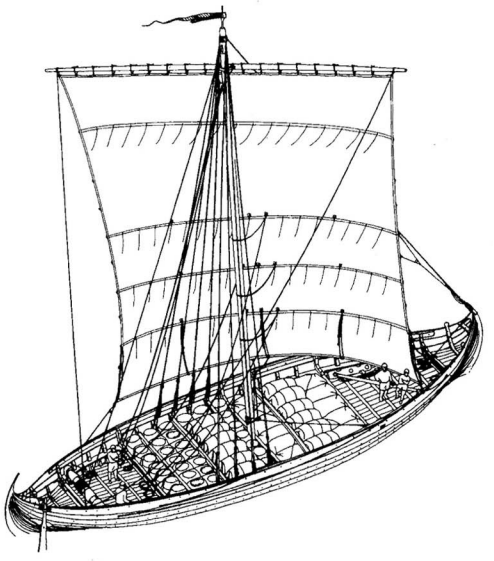
Built of oak around AD1080 she is a small, elegant trading vessel 13.8 metres long, 3.4 metres wide amidships and has a draught of 85 centimetres. She is decked fore and aft, leaving a large open hold amidships with a volume of 10 cubic metres, which would have held about 4.5 tons of cargo.

The keel, about 9 metres long, is scarfed with iron nails and trenails to the steeply rising stem and stern, the former of which is beautifully preserved. The hull consists of eight broad strakes on each side, the top four of which are strengthened along their upper edges by longitudinal stringers. The ship has 11 evenly spaced ribs and a triangular bulkhead at the bow, which features a stout knob to which an anchor or mooring rope could be attached. The ribs extend over the first four strakes and halfway across the fifth. The tops of the ribs support the first stringer, which lies flush with the upper edge of strake five, and supports the lower crossbeams. Knees secured to each end of the crossbeams support the second stringer, which in turn supports the upper crossbeams. These are rebated to receive the loose planking that forms the decking fore and aft. Upper crossbeams are absent amidships over the hold, except for the mast-beam, which is of a more robust construction than its fellows, and is secured to both the stringers and the hull by substantial horizontal and vertical knees.

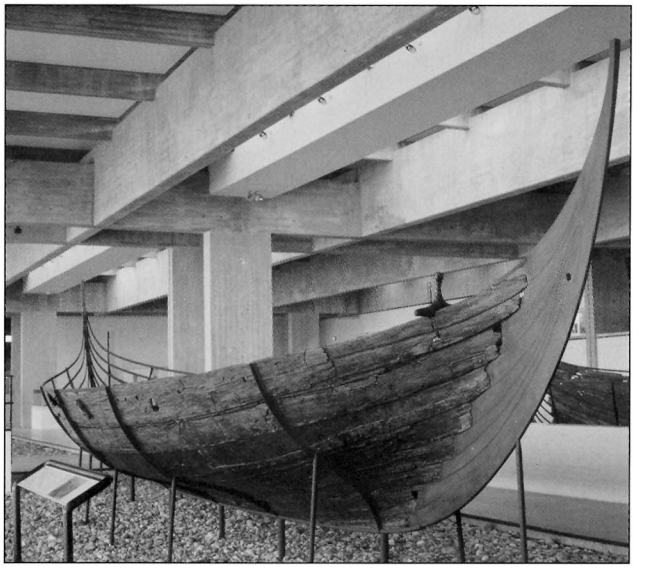
The keelson is 3.7 metres long and spans three of the ship's ribs. It is deeply stepped to receive the mast, and the vertical mast support rising from it is firmly mortised into the mast-beam.

The gunwale is pierced with seven rectangular oar holes, two forward to starboard, three to port and one on each side aft of the hold. Oars would be used when manoeuvring the vessel, or over short distances when becalmed, but the prime means of propulsion was the sail. Much has been learned from Skuldelev 3 regarding rigging arrangements, as the gunwale features a number of holes that would have accommodated both standing and running rigging. Cleats were also found inboard and on each side of the gunwale outboard. Skuldelev 3 has been the inspiration for a number of replicas, notably '*Roar Ege*', the first reconstruction to be undertaken at Roskilde and launched in 1984.

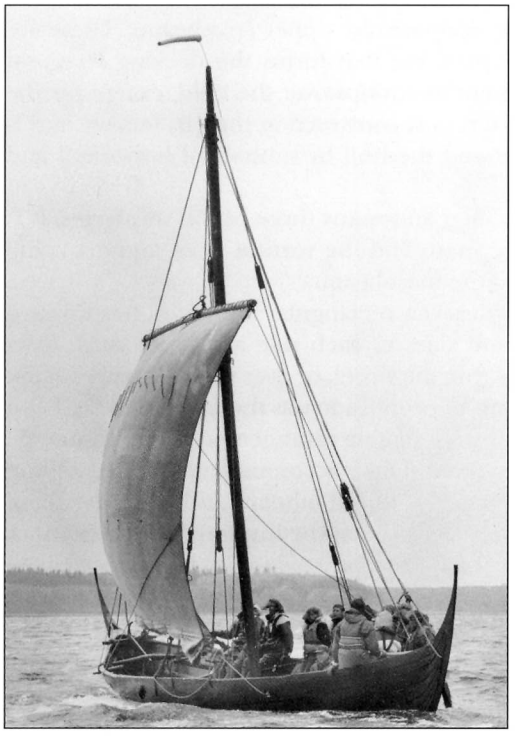
Under a sail of 45 square metres and with a crew of five to eight people, this fine little ship has achieved speeds in excess of 8 knots, and when sailing at an angle into the wind, could beat at 60 degrees with a leeway of 5 to 6 degrees.

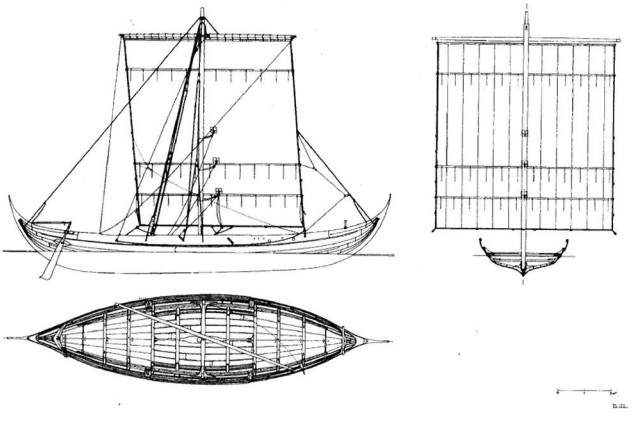


Reconstruction of a large ocean-going *knarr*, the remains of which were discovered in the harbour at Hedeby/Haithabu. The ship has been estimated at 22.08 metres long, 6.2 metres wide amidships and 2.52 metres high. Note the large hold amidships that would have held in the region of 60 tons of cargo, more than twice as much as Skuldelev 1. (Drawing: Sune Villum-Nielson, from '*Viking Age Ships and Shipbuilding in Hedeby/Haithabu and Schleswig*' (Ole Crumlin-Pedersen 1997)



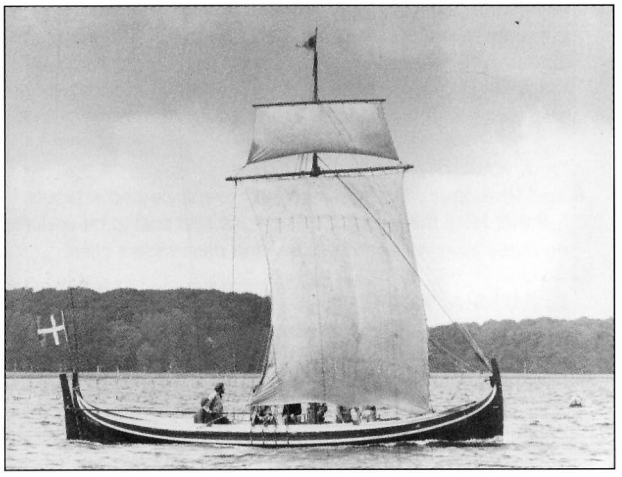
The well-preserved remains of the small coastal trader known as Skuldelev 3 have been the inspiration for a number of replicas. Such ships were the workhorses of the Viking era and would have plied Danish coastal waters and the Baltic. Note the reproduction prow, the original being carved from a single block of oak. (Photo, Werner Karrasch, Viking Ship Museum, Roskilde)



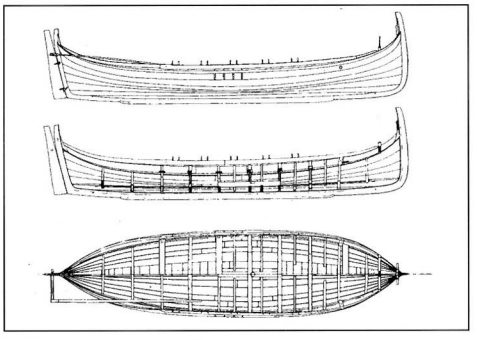


ABOVE **'*Roar Ege*', its pilot rigging and overall arrangement. (Drawing, Erik Andersen. The Viking Ship Museum, Roskilde)**

LEFT **With her sail lowered and reefed, '*Roar Ege*' slips through the short, choppy waves of Roskilde Fjord. (Photo, Werner Karrasch, The Viking Ship Museum, Roskilde)**



ABOVE **The Viking ancestry of this Nordlandsbåden is clearly apparent. This ship, the 'Rana' was built in north Norway in 1890. Now fully restored, she is frequently sailed on Roskilde Fjord. (Photo, Lars Kann Rasmussen, The Viking Ship Museum, Roskilde)**



RIGHT **Detailed line drawings of the 'Rana'.**

CONCLUSION

By the mid-13th century, the growing strength and stability of the larger European kingdoms led to widespread commercial expansion. Profit became the driving force behind ship design, and soon the '*cog*', with its deep draught and massive cargo hold, began to replace the trusted *knarr*. Warships followed a similar path, and the slim, predatory *langskips* were abandoned for high-sided vessels that sprouted wooden castles fore and aft. The age of the Viking ship was over.

Old habits die hard, however, and in remoter parts of the northern hemisphere many seafarers refused to abandon these elegant, seaworthy vessels simply because their time was past. As a consequence, until the end of the 19th century, traditionally built, north Norwegian *fembørings* and their hardy crews still plied the same, grey northern seas as did their forefathers a thousand years before.

GLOSSARY

Amidships the centre of the vessel
Beam the width of the vessel
Beiti-ass a wooden spar used to tauten sail when tacking
Bowline a line running from forward edge of sail to bow, which keeps sail taut
Braces lines to control the angle of the yard
Caulking a fibrous mixture of animal hair and tar that is packed between two overlapping strakes, making the joint watertight
Clinker-building building the shell of a boat with a series of overlapping strakes
Crossbeam a transverse timber spanning the hull
Garboard the first strake attached to the keel
Gunwale the upper edge of a ship's side
Halyard a rope for raising and lowering the sail
Heeling when a vessel leans over to one side because of pressure of the wind when under sail
Hogging when pressure of the sea causes the bow and stern to droop and the vessel is in danger of breaking its back amidships
Keelson a longitudinal timber resting over the keel
Land an area where two strakes overlap
Mast-step a fitting to locate the heel of the mast in the keelson
Priare a triple sheet attached to the middle lower edge of the sail
Rabbet or **rebate** a groove cut into a timber to receive the edge of another timber
Rakke a collar of rope or wood that keeps the yard attached to the mast but allows vertical movement
Reef reducing the area of the sail
Rove a small perforated metal plate through which a nail is passed then clenched over it
Rowlock a fulcrum for an oar fixed to the top of the gunwale
Scarf an angled joint between two timbers
Sheerstrake the uppermost strake in the hull
Sheet a rope fastened to lower corners of sail
Shroud a rope that supports the mast and runs from the mast-head to the hull amidships
Stays ropes running from the mast-head to the bow and stern to give longitudinal support to the mast
Strake a plank forming part of the side of a vessel
Stringer a wooden member running inboard fore and aft that gives longitudinal strength to the hull
Tacking manoeuvre by which a ship beats to windward
Thwart a transverse bench or crossbeam
Trenail a round wooden peg sometimes slotted to take a wedge and used to fasten strakes to ribs and knees
Yard a timber or spar from which the sail is suspended

COLOUR PLATE COMMENTARY

A: THE GOKSTAD SHIP

The Gokstad ship was found with 64 shields *in situ*, 32 lining each of her sides and painted alternately black and yellow. The ship was built c.890, and picture stones from this period show ships with chequered sails and dragon-headed prows. The figurehead is based on an animal-headed post found among the Gokstad grave furnishings and along with the sail, is coloured black and yellow in keeping with the shields. Note the spears stored at the stern, and the weather vane, both of which follow examples on a picture stone from Smiss, Stenkyrka, in Gotland. The effect of being underground for 1,000 years has considerably darkened the ship's timbers, which originally would have been much lighter than they are today.

B: SHIP CONSTRUCTION, 9TH CENTURY

1) Interior of the Oseberg ship showing the method of attaching the strakes to the ribs by means of integral cleats. Note the L-shaped *meginhufr*, third strake from the gunwale.
2) The mast support system of the Gokstad ship: Note the arched mast-fish and the integral, vertical arm rising from the keelson, which braces the mast. Also shown are the upper ribs, shield rack and the shuttered oar holes.
3) Method of attaching the steerboard to the hull: Note the strong plank that forms the vertical rudder rib through which the rudder withy is secured.
4) Weather vanes from ships prows and mast-heads often ended their days on church steeples, such as this one from Söderala, Sweden.
5) Various tools used in shipbuilding:
i) top row – from the left – a breast auger and bits, side-axe, adze.
ii) middle row - two moulding irons.
bottom row – from the left – a hafted wedge, hammer and tongs.
6) Cross sections of the Oseberg ship (a) and the Gokstad ship (b). The higher freeboard and more robust nature of the Gokstad ship is clearly apparent.

C: THE OSEBERG SHIP

The Oseberg ship had been placed in a large trench and was found with its rudder in place and its prow pointing south toward the open sea. It contained the skeletons of two women, probably a queen and her bondswoman. They had been laid to rest in a burial chamber erected behind the mast of this elegant vessel, which would transport them on their last journey across the sea to the land of the dead.

Once the dead had been placed on board with their possessions and equipment, the ship was secured in the grave by means of a stout hawser tied to a large stone near the prow. Rocks were then placed on top of and around the ship and these in turn were covered by a mound of peat turves that were tightly packed one on top of the other, grass side up. With the passage of time, however, the enormous weight of the mound – estimated at 6,000 tons – gradually caused the base of the grave to collapse and the resultant subsidence badly crushed the ship, drastically altering its shape, to the extent that the keel was discovered at a higher level than the gunwales. Although both the ship and its contents were crushed into thousands of fragments, the actual timber was so well preserved that it was possible, after many years of conservation, to reshape and reconstruct the ship along with the majority of the artefacts interred with it.

D: A *KNARR*, 11TH CENTURY

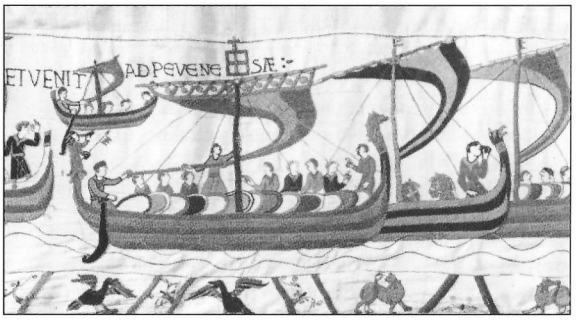
An 11th-century *knarr* as it would have appeared en route to Iceland. Note the exposed conditions that had to be endured on these long voyages by crew and passengers alike.

E: RUSSIA, AD950–1000

When Swedish Vikings, or Rus as they came to be known, crossed the Baltic in search of trade and plunder, they came upon a vast land of forest and steppe inhabited by primitive Slavic tribes that quickly fell prey to their swords and axes. Establishing strong-points and thriving trading centres such as Kiev, Ladoga and Novgorod, they controlled the trading routes down the Dneiper and Volga, carrying cargoes of iron, wax, furs, amber and slaves to the exotic markets of Byzantium, which they called 'Miklagard' – 'Great City'.

These epic journeys could prove to be long and perilous enterprises, and ships appear to have travelled in large flotillas for safety. In order to navigate narrow or very shallow stretches of water, the vessels used by the Rus would certainly have been no larger than the Skuldelev coastal trader that is depicted here. In addition, ships had to be light enough to be physically dragged across land when rivers petered out or where rapids made them impossible to navigate.

Here, the Rus have felled and trimmed timber over which the ship is being hauled by means of a heavy cable passed around the stern, a method that recent experimental archaeology has proved particularly effective. Slaves and horses may also have been employed in transporting ships across land, possibly in conjunction with rudimentary sets of wheels that could easily be fashioned on site. Note the smaller boats moored upriver and the tents, which follow examples from the Gokstad and Oseberg finds.



The flagship *Mora* in which William, Duke of Normandy, led his fleet across the Channel in 1066. In keeping with William's rank, the ship is suitably adorned with an elaborate dragon-headed prow, and inboard has a full row of overlapping kite-shaped shields. Curiously, no oar holes are depicted. Note the accompanying ships carrying horses and the smaller vessel above the *Mora*'s stern. (The Bayeux Tapestry, 11th century. By special permission of the City of Bayeux)

Much has been learned from experimental archaeology, and here horses are being transported in the Ladby ship replica '*Imme Gram*', giving credibility to similar scenes depicted in the Bayeux Tapestry. (Photo, Ole Crumlin-Pedersen, The Viking Ship Museum, Roskilde)

F: SHIP CONSTRUCTION, 11TH CENTURY

1) This prow, hewn from a single block of timber, is carved to follow the lines of the ship's strakes, which it is rebated to receive. Note the dragon-head from the '*Helge Ask*' and the manner of attachment to the prow.

2) Method of construction that had been established by the 11th century, using trenails to secure the strakes to the ribs. Note the upper crossbeams, or thwarts, which could serve as benches for oarsmen, and above the keelson, the sturdy mast-beam.

3) Left to right; scarf joint, rove, rivet and tarred rope, rib, clinker-built strakes and trenails.

4) Two kinds of shroud-pin or vantnale and the manner in which they are used to secure the shrouds to the hull.

5) Cross sections of (a) Skuldelev 1, a deep-sided ocean going *knarr*, and (b) Skuldelev 5, a small, narrow warship.

G: THE *MORA* AND THE NORMAN INVASION FLEET, 1066

Led by William's flagship, the *Mora*, the Norman fleet leaves the Somme estuary at dusk on 27 September 1066. Oars are being deployed to manoeuvre the ship, and while the crew make ready to sail, a man in the bow fixes the *Mora's* dragon-head to her prow. Many of the longships depicted in the Bayeux Tapestry feature square blocks just below their dragon-heads, which could well be wedges, by which they are secured to the prows. When the ships are seen beached at Pevensey their dragon-heads, in keeping with tradition, have been removed and these blocks are no longer shown. The *Mora's* prow, sail and hull are decorated as shown in the Tapestry.

We are told that William gave the signal to set sail by lighting a lantern hung at the *Mora's* mast-head, and by the sounding of a horn. In the Tapestry, the *Mora* does indeed have a cage-like structure surmounted by a crucifix at her mast-head which may represent a lantern. At the stern, what could be interpreted as a squire displays William's colours and sounds a blast-horn. However, bearing in mind the aforementioned crucifix and the strong degree of moral righteousness that William attached to the invasion, this may simply depict a carved angel decorating the stern post.

William's fleet has been estimated at between 700 and 750 ships and probably consisted of every seagoing vessel imaginable from the period. Here we see provisions, equipment and weapons being ferried to the larger ships by small cargo boats, while *knarrs* and cargo vessels, which are generally shieldless, are used to transport the horses.

Horses being transported in Viking ships, as depicted in the Bayeux Tapestry. (The Bayeux Tapestry, 11th century. By special permission of the City of Bayeux)

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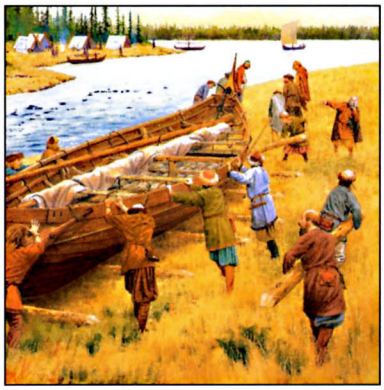
The design, development, operation and history of the machinery of warfare through the ages.



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Viking Longship

Viking longships evolved from one-man canoes of the Scandinavian Stone Age, through wood-built-ships of c. 200 BC into the recognisable longboats of the 4th century AD. From this point, the Viking longship developed into the pre-eminent raider and trader in the North Sea and Baltic, venturing as far afield as the Mediterranean, North Atlantic and modern-day Russia.
This book uses reconstructions, original sources, translations and archaeological evidence to render a vivid picture of the vessels that dominated the seaways of Scandinavia, founded colonies on Iceland, Greenland and the New World and terrorised the coastlines of Northern Europe. Norman vessels are also covered, including the invasion fleet of William the Conqueror.

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